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Economic feasibility of the Northern Sea Route container shipping development

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Preface

The master thesis is written as the final assignment of the Master of Science in Business program and Logistics and Transport specialization.

We would like to thank our supervisor Professor Finn Jørgensen for his responsive attention, valuable comments and constructive critics.

We are also very grateful to the representatives of different organizations, who participated in provided interviews: the representatives of Ocean Futures- Senior Research Fellow Amfinn Jørgensen-Dahl and Research Fellow Karl Magnus L. Eger; Senior Researcher with DNV Research and Innovation Knut Espen Solberg; President and CEO of Beluga Shipping Niels Stolberg; Regional Director of Barents Rambol Rune Rautio. The primary data would be impossible to gather without their collaboration.

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Abstract

From year to year the traffic of goods between Europe and Asia rises, the need for a new route for transportation becomes more and more obvious. The new route should be competitive to the others and has its own competitive advantage. Nowadays an extra day of transportation can increase costs dramatically for trade companies, so it is necessary to develop a route, which have a short transportation period as the main advantage. The Northern Sea Route is the challenging candidate. The research corresponds studying of major advantages and disadvantages of international transportation through the NSR. The case study, provided in the research, has a target to estimate costs of establishing a permanent transportation line along the NSR between East and West; calculation of the operating costs for the line and the comparison to the route through Suez Canal. The main aim of the research is to find out, if it is feasible for shippers to use the NSR for transit container shipping. The empirical part of the research is devoted to the collection data about the current state of the NSR development, interested parties of this development and the legal framework for NSR use. The data gathered from different sources, which include interviews with representatives of companies and organizations, interested in further NSR development, official guidelines and researches, based on similar topics. Analysis and further discussion revealed that the NSR can be competitive with comparison to the route through Suez Canal in the nearest future, if the work on solving current problems is successfully performed. During the research it was concluded, that the use of the NSR is not feasible nowadays, but the changes in legal framework, fees and global climate can bring the condition of the NSR closer to competitive level.

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List of abbreviations

DAS- double-acting ships

EHP- effective horse power

FO- fuel oil

IFO- intermediate fuel oil

IMO- International Maritime Organization

ISO- International Organization for Standardization

NSR- Northern Sea Route

RF- Russian Federation

TEU- twenty-foot equivalent unit

USD- United States dollars

1. Introduction

1.1. Motivation of the study

The globalization of production is inseparable from the globalization of trade, because one cannot function without the other functioning. According to Rodrigue, et al (2009), since its appearance the international trade has enormously increased its scale for the past 600 years to play even more active role in the economic life of nations.

The technical evolution in transport sector has played the significant role in this tendency. It was reached the point where the larger distances can be traded for the smaller amount of time and for different scales of costs. Thereby, trade contributes to lower costs now (Rodrigue, 2009).

Nowadays freight transportation is one of the most important activities, which supports economic activities of increasing world trade globalization. According to the University of Mainheim, sea transportation takes the leading position in international cargo transportation rating.

It is conditioned by several advantages, such as relatively cheap prices and high capacity conveyance. But as usual, it has also several disadvantages. It needs longer transport time and its schedule can be affected by the weather condition.

Rodrigue (2009) argues that the importance of maritime transportation in global freight trade cannot be underestimated, because it handles about 90% of the global freight transportation in terms of tonnage; thereby, globalization is the realm of maritime shipping, with containerized shipping at the forefront of the process. The global maritime transport system is composed of major gateways granting access both to production and consumption regions.

The growing development of the trade connections between Europe and Asia provides the growth of the cargo transfer between East and West. The main route between these destinations is Suez Canal, or so-called Royal Route. From 1975 the Suez Canal has been the major trade route.

It operates most of the containerized traffic between Asia and Europe: according to Dewry (2008) more than 20 200 ships and 745 million tons of freight in 2007. Increasing containerized traffic from Asia starts to affect activity of the Canal. At present, 46% of vessels

transiting the Canal are container ships. Despite construction intended to increase the maximum ship size (14 000-16 000 TEU) in 2010, the Suez Canal probably will soon reach its limits

Nowadays the melting of the arctic ice opens the new maritime route between the markets of Northern Asia and North-Western Europe, passing through the Arctic Ocean - Northern Sea Route, or also so-called North-East Passage- as a possible alternative for Royal route through the Suez Canal.

The Northern Sea Route is a shipping lane from the Atlantic Ocean to the Pacific Ocean along the Russian Arctic coast from the Barents Sea, along Siberia, to the Far East. Historically the motivation to navigate the Northeast Passage was initially economic.

Figure 1.1: Comparative map of the NSR and the Royal Route (Source: Kramer, Revkin, 2009)

As it can be seen from the figure above, the Northern Sea Route is almost twice as shorter than Suez Canal. It can be illustrated by the comparative table below:

The Length Of A Voyage To Rotterdam From Different Ports By Suez Canal And NSR			
	Suez Canal (miles)	NSR (miles)	Distance saving in percentage (%)
Rotterdam-Yokohama	12,894	8,452	34,45
Rotterdam-Shanghai	12,107	9,297	23,2
Rotterdam-Vancouver	10,262	8,032	21,67

Table 1.1: The length of a voyage to Rotterdam from different ports by Suez Canal And NSR.

Several seaports along the NSR are ice-free all year round (Laiho, et al., 2005). They are, west to east, Murmansk on the Kola Peninsula, and on Russia's Pacific seaboard Petropavlovsk in Kamchatka, Vanino, Nakhodka, and Vladivostok [Laiho, et al, 2005]. Arctic ports are generally usable July to October, or, such as Dudinka, are being served by nuclear powered icebreakers.

Since its discovery the Route was mainly used by Russia, but not by other countries. Only explorers were travelling for the whole route, others were using only ice-free part of it for reaching northern part of the middle Russia. After the breakup of the Soviet Union in the early 1990s, commercial navigation in the Siberian Arctic went into decline. (Laiho, et al., 2005).

During the last ten years the interest to the Northern Sea Route is increasing. In 1998 NSR has received the status of independent Eurasian maritime transport corridor. Also Russia has published the Rules to be followed on the Northern Sea Route, signing the navigation description, ecological and safety norms.

Despite of the fact that there are some regulations and rules, it is still very difficult to get a permission to use the route for non-Russian citizens. Due to that fact, the traffic at the route nowadays is very little.

Keeping in mind the growing turnover between Europe and Asia, It is highly important to develop new routes for shipping, so it seems to be reasonable to conduct the research,

touching the topic of possible development of Northern Sea Route as the feasible maritime channel. The advantages and weak points need to be defined, as well as the ways of current navigational problems solution should be found out.

1.2. Problem Statement

The main part of the master thesis "The Economic Feasibility Analysis of Northern Sea Route" is the combination of theoretical and empirical studies, in order to answer the main question which arises during the research and can be called as problem statement:

Will it be economically feasible for shippers to use the NSR for the transit shipping?

Economic feasibility analysis is the most frequently used method for evaluating the effectiveness of a new system (Bentley, Whitten, 2007). The problem statement provides the context for the research study and allows generating further questions which are essential to answer.

The main questions that will be probed to answer in this study are:

- Can the use of the Northern Sea Route be profitable for private shippers?
- Who are the interested parties of the development of Northern Sea Route?
- What is made and what will be done to make the route functioning and profitable?
- What legal and regulatory documents, connected with the NSR, exist?
- What are the main obstacles of wide usage of the NSR?

This research problem statement contains two variables and measurable relationship between them. This lets the researchers to set the theoretical and empirical fields for the research study. The problem statement is close to the question statement because question detection enables to define the design, research strategy and methods of providing the research study, and the whole research study will be a detailed answer for the problem statement.

1.3. Organization of the thesis

The research consists of four chapters, each of them is divided into subchapters and subsections for better patterning and easier material feed.

The first chapter is devoted to theoretical background and contains several important aspects of freight transportation itself; costs, connected with that and infrastructure, which is necessary for successful and convenient navigation. The theoretical background is aimed to uncover the ideal conditions for international maritime trading route.

The second chapter performs the aspects of methodological part of the research, such as chosen philosophical position; research design and strategy; discussion of different method types of gathering information, such as interviews, case study and secondary data sources review. The chapter also raises the question of validity and reliability of the research.

Empirical background is represented in the third chapter. It contains the general data about NSR history and present development, which was collected from the secondary sources of information; also it includes the gathered interviews of senior managers of several stakeholders companies of NSR development; the collected data about Russian governmental regulations, connected with providing of navigation along the Russian coastline; information about demand on NSR as a trading route and the competitor of such trading channels as Suez and Panama Canals.

Analysis and discussion of all gathered empirical data is presented in the forth chapter. This chapter is aimed to compare the theoretical models and real condition, reflected in empirical data. It intends to reveal the possible advantages and disadvantages of NSR as a world trading route, estimates the feasibility of opening NSR for international navigation and proposes the possible actions to achieve that.

1.4. Limitations of the study

This study has a number of limitations which are necessary to be mentioned. The in-depth interviews as the main source of information set up the researchers into the limits of the gathered opinions, leave traces on their conclusions and can affect the course of discussion and further analysis.

The limited number of provided interviews and the fact that several of them were gathered in written form, while others were taken by the telephone, are also the limits for the presented research.

The experiences of previous studies and opinions of stakeholders affect the summary of this work and restrict the conclusions made by the researchers.

2. Methodology

2.1. Discussion of philosophy position

During the history of science three philosophical approaches became traditional. They are positivism, relativism and social constructionism (Easterby-Smith, et al., 2008).

Positivism is a philosophy which holds the only authentic knowledge is that which is based on actual sense experience. According to Easterby-Smith (2008), the key idea of positivism is that the social world exists externally, the reality should be measured objectively, as if a person, who is trying to do that, is just an external observer, and he or she is not interacting with the observable reality. In this particular study, will not be any experiment, which will be provided and observed, so this philosophical approach is not appropriate.

The second and opposite to positivism paradigm, the paradigm of social constructionism was formed and developed during the last half century. The key figures of social constructionism are:

- The reality is formed and determined by people's perception and mostly exists in people's minds, rather than specified by objective and external factors.
- A lot of attention should be paid to people's personal and collective opinions, on their thoughts and the way, they communicate with each other.
- The researcher is a part of the studied society and should not be excluded from it (Easterby-Smith, et al., 2008).

This constructionist approach also cannot be used in this study, because according to this approach: the researcher is a part of the studied society and should not be excluded from it (Easterby-Smith, et al., 2008); but this research will be made from outside, the researchers will not be involved in development of the Northern Sea Route and are able to analyze only from outside.

Disparity of two approaches described above leads the researchers to observation of the third form of philosophical method, called relativism, or to mixed types of research strategy. In the research study "Economic feasibility of the Northern Sea Route container shipping development" it seems to be reasonable to pay attention on relativist position. Relativist paradigm appeared from positivist one and was arguing with positivism that scientists should be involved in the process of cognition and the process of discovery influences the result of the

study. Also it claims that the feasibility of theory may "vary from time to time and from place to place" (Easterby-Smith, et al., 2008).

Paradigm is not absolute; it can change through scientific revolution, which happens when a lot of abnormalities occur.

In this particular research the main object for observation in the development of the Northern Sea Route. The main questions that will be probed to answer in this study are:

- Is the development of Northern Sea Route profitable and who are the interested parties?
- What is made and what will be done to make the route functioning and profitable?
- What are the characteristics of the vessels that will be used on the route?

The main way for achieving the truth, due to relativism, is triangulation - a powerful technique that facilitates validation of data through cross verification from more than two sources. In particular it refers to the application and combination of several research methodologies in the study of the same phenomenon (Bogdan, Biklen, 2006). Triangulation will be a useful tool for combining data, collected during the interviews, theoretical framework and statistical information.

The philosophical position of relativism is appropriate for comparing different alternatives, while making a choice. There cannot be one opinion, when the decision between few alternatives is made, every observer will see the situation from his own point of view, thus for making the final decision, all the opinions should be gathered, every "pro" and "contra" for each option need to be taken into account, and then finally the truth will be found. Such a philosophical approach is the most appropriate one for a study, called "Economic feasibility of the Northern Sea Route container shipping development".

The relativist approach helps to accept value of multiple data sources and thereby grants greater efficiency by including outsourcing materials and opinions (Easterby-Smith, et al., 2008). For example, when people will be interviewed about the today condition of the route development, they will give different qualitative data as answers, but this data can be analyzed and the final complete picture of current condition can be formed.

This approach can be used, despite of the problems that can be occurred while reconciling discrepant information, because the data collected is statistical and primary, and so the

probability of any discord will be very low, but even if any discord occurs, the total picture of the studied subject can be received by using strategy and methods, described lower in this study.

2.2. Research strategy/ design

While creating a research strategy, it is necessary not only to decide, how the data will be collected, but also explain the way the collected data will be analyzed and how that will help to find answers to the main questions of the research. The most important condition for choosing a research strategy is to select a set of methods that fit the type of research question being asked. The key question of the study is "Is the development of the Northern Sea Route economically profitable?" To answer this question interviews are needed, later they will be analyzed according to hermeneutics study, and a case study will be designed and solved to get applicable result.

The design of the interview will be discussed in more details at the next part of the study, but it is needed to pay more attention to hermeneutics, which will help to interpret the results of the interviews and analyze their meanings for research results (Willis, Jost, 2007).

2.2.1. Hermeneutics

Packer and Addison say that science presents an objective, unbiased, interpretation-free procedure for recording observations about phenomena being studied (1989). However, hermeneutic epistemology rejects the assumptions that unbiased observation is possible, all observation precedes and is independent of (is not tainted by) prior conceptions, and numerical systems are inherently passive forms of data representation.

A researcher's position on these issues reflects normative commitments regarding the role of interpretation in research. (Patterson, Williams, 2002). In this particular study the correct interpretation of the interview answers is very important, because there are not much standard questions for interviewers and the received answers may be formulated differently, so it is necessary to interpret all the answers correctly and reduce them to "common denominator" to make a comparison possible.

2.2.2. Types of methods

It can be said that methodology is a logical structuring of researcher activity consisting in determining the goals and objectives, research approaches and guidance in its custody, the choice of means and methods for determining the best result. Research methods are a variety of techniques to explore a given phenomenon. The methodology always starts from definition of the aim of research. Aims should enlighten the general intentions of the research, stress what is to be reached. The aim of this research is the feasibility analysis of the Northern Sea Route.

Every scientific work has to have the structure, which helps to systemize the research. It is usually called design. Different types of research designs have different advantages and disadvantages. They are usually divided into two general groups: quantitative and qualitative. But it seems to be rational that these designs can also be examined through the prism of epistemology. As it was said above, this research bears the social-constructivist character. There is quite a wide range of methodologies which fit within the constructionist paradigms. Here it is necessary to mention such universal method as case study.

This work will contain the case study, it will be based on qualitative data analysis, gathered from the secondary sources of information, such as statistics posted on suppliers' official web-sites and the rates of the NSR posted in law of Russian Federation. But this case study is supposed to be an illustration of falsification or verification of the results which was accommodated through the research.

It would be reasonable to structure the research in frames of descriptive research design, which involves the collection of data in order to test hypotheses or to answer questions concerning the current status and future predictions about subjects of the study.

Although due to the objective of the research, it is necessary to mention that this research is studying new field of transport logistics in cause of recent possible opportunities for opening the new world trade route, that is why elements of exploratory research type would be also used in this research. Exploratory design helps to define research hypotheses, but it doesn't strive to prove them. Exploratory research can be performed using a literature search, surveying certain people about their experiences, focus groups, and case studies.

2.2.3. Case Study

After interview analysis, the case study, based on the analysis results, will be developed and solved. That will allow modeling the situation, when the Northern Sea Route is already in use and calculate the economic feasibility of using it for a certain freight company. The case study will analyze the possibility to use new type of ice-breakers that can transport cargo themselves at a good average speed, while there are no ice, and turning back forward to overcome the ice fields.

Case study research excels at bringing researchers to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous

research. Case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships (Soy, 1997).

Social scientists, in particular, have made wide use of this qualitative research method to examine contemporary real-life situations and provide the basis for the application of ideas and extension of methods. Researcher Robert K. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984).

According to Yin's (1993) and Stake's (1995) classification, there are six types of case studies: exploratory, explanatory, descriptive, intrinsic, instrumental and collective. An exploratory research design tries to precisely define the research question and form hypotheses. In an explanatory case study, the collection of data occurs before theories or specific research questions are formulated. Descriptive research design goes a bit further and tries to describe different characteristics of a phenomenon.

The descriptive case study will require a theory to guide the collection of data. The explanatory research design can be used when the research field has matured. This design tries to explain course of events and relate how things happened. Intrinsic research design in used when the researcher has genuine interest at the case and trying better understand it. This method can not be used for route analysis, because the researchers should be involved in process and know the subject and want to widen the knowledge.

Instrumental approach is not needed in this study, because the case is of secondary interest; it plays a supportive role, facilitating our understanding of something else (Stake, 1995). Collective case study means that the researcher is providing few different case studies to find out a tendency or a pattern, but at this particular research there is no need to make few case studies, because here the case study is needed to combine and implement the results of research.

The main objective of the study will be the investigation of economic profitability of a new maritime route, and that is why exploratory case study is the most appropriate one. Due to the fact that there are some researches made before this one, this case study can be explanatory as well, because the theoretical background and previous researches are analyzed before formulation the main research questions.

The study will seek for a future status of the route, so, according to Sevilla at alias (1992), trend analysis will be an appropriate method to use. It is needed to find out the future prices of transportation, using the Northern Sea Route, future condition of infrastructure and make a prognosis about probable toll rates and demand for the route. That will be a long-term prediction and it will not be very reliable, because many independent factors, like governmental policy, economical situation, world politics, project financing, etc., can not be predicted exactly, that is another reason, why finally case study will be used. The trend will be analyzed and then the case study will be designed, based on the predicted status of factors, mentioned above.

2.2.4. Interviews

Interviews play an important role in this study. The data collection method for this research is qualitative one, as it was said above, and qualitative interviewing is its main tool. Qualitative interviewing is usually very different from quantitative research approach to interviewing. Quantitative research is aimed presumably on developing rich statistical general data through a large number of interviews and maximizing the reliability and validity of measurement of key concepts; hence it is reasonable to use strictly structured interviews to simplify the data analysis process.

In opposite, the qualitative interviews usually use unstructured or semi-structured forms in aim to understand the interviewee's point of view. The qualitative research interview seeks to describe the meanings of central themes about the subjects (Kvale, 1996). It is accepted that there are two main types of interviews in qualitative research:

- Unstructured: during this interview, interviewee gets the right to respond freely, say everything he or she believes is necessary. This type of interview reminds a conversation (Burgess, 1984). Interviewer can set only the common range of topics he wants to discuss, usually the interview starts from the key question and allow respondent to express its opinion about that topic. It can be seemed that this type of interview can provide the researcher with rich data about his concerns and deep understanding the problem, but it usually a mistake, because due to absence of structure, the respondents often avoid to talk substantially and digress from the subject of the conversation, because of their uncertainty of what the researcher exactly wants to know. (Easterby-Smith, 2003).

- Semi-structured: during this interview, the researcher usually has a common set of questions, so-called interview guide. But in contrast to structured interviews, here the interviewee has a leeway in his answers. Questions may not follow on exactly in the way outlined on the list. New questions may arise during the interview as they pick up on things said by interviewers.

The two different types of interview in qualitative research are extremes and there is quite a lot of variability between them. In this research it seems to be reasonable to use the semi-structured types of interviews; because distance between researchers and interviewees and difficulty of providing interviews by phone calls and e-mail are strive the researchers to use semi-structured interviews to highlight the main aspects of problem to interviewee and get more organized answers. This helps to analyze the derived data more properly and make diversified conclusions.

Easterby-Smith (2008) said that there are 6 primary important issues that can affect the results and analysis of interview, such as: obtaining trust, being aware of social interactions, using the appropriate language, getting access, choosing the location for the interviews, and recording interviews.

Due to variety of different opinions about the main problem of this particular research, it seems to be sensible to gather and systemize the brightest of them by means of interview.

Providing interviews by telephone and via e-mail is full of so-called “reefs”. This method is often very appropriate for managers, because of its flexibility. It is easily rescheduled and less obligatory. And what may be seemed as advantages can become a disadvantage. That is why it is become important to use such technique as critical incident technique. This technique offers an opportunity to go straight to the main problems, avoiding gathering a batch of information, which can be or can not be relevant to the main issues of the research (Flanagan, 1954).

It is planned to construct interviews, using the critical incident technique. All interviews are built up concerning the characteristics and activity of interesting companies and their part in the development of the research subject.

Several CEO were interviewed during the study, their names and positions are presented in the table below:

Name	Company	Position
Amfinn Jørgensen-Dahl	**Ocean Futures** Borggata, 2B Oslo, Norway NO-0608	Senior Research Fellow, PhD
Karl Magnus L.Eger	**Ocean Futures** Borggata, 2B Oslo, Norway NO-0608	Research Fellow
Knut Espen Solberg	**Det Norske Veritas (DNV)** Veritasveien, 1 Høvik, Oslo, Norway NO-1363	Senior Researcher with DNV Research and Innovation
Niels Stolberg	**Beluga Shipping GmbH** Beluga Projects (Norway) AS 6th fl. Lars Hertervigs Gate, 3 Stavanger, Norway NO-4005	President and CEO
Rune Rautio	**Ramboll Barents** Portoviy proezd, 21 Murmansk, Russia RU-183038	Regional Director

Table 2.1: List of interviewees

2.2.5. Secondary Data

Another important source of information of that study is secondary data. First of all it includes the literature observation which helps to uncover the theoretical background of the problem; the printings and articles about development of NSR, freight transport and aspects of governmental regulation of NSR and another trade routes. Internet is used as the abundant source of timely information about changes of world tendencies, concerning marine logistics and news about Arctic areas.

2.3. ***Validity and Reliability***

The terms of validity and reliability are basics for successful scientific research. They can be called "scientific proof". "Validity is the best available approximation to the truth of a given proposition, inference or conclusion" (Trochim, 1999). Validity's aim is to encompass the whole experimental concept and establishes whether the results obtained meet all of the requirements of the scientific research method. Reliability is the extent to which a measurement is repeatable with the same results. A measurement may be reliable and not valid. However, if a measurement is valid, then it also is reliable and if it is not reliable, then it cannot be valid.

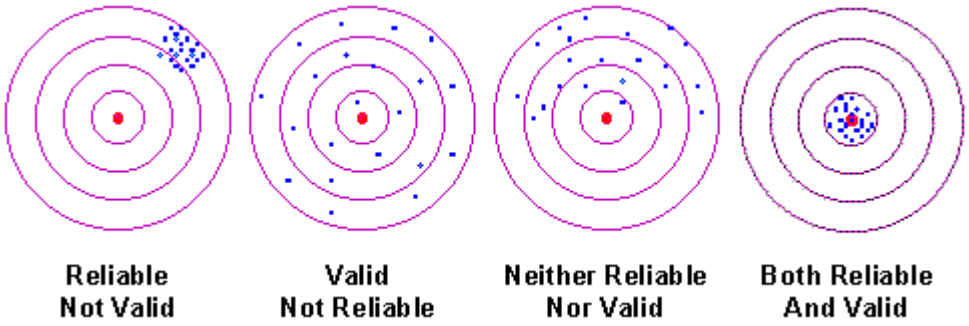

Figure 2.1: Four possible relations between validity and reliability (Source: Trochim, 2006)

This figure above shows four possible situations of different relationship between validity and reliability. The red dot in the center is supposed to be the purpose of research, and the blue dots are the measures of value, which can be relevant or not to the object of the research. In this current research, the red dot is the status of NSR competence and the blue dots are the interviews with the CEO of interesting companies, case study and observation of secondary data.

Due to qualitative method of the research it is necessary to be concerned about the external and internal validities, The main criteria of external validity is the process of generalization, and whether results obtained from a small sample group, it can be extended to make predictions about the entire problem. Internal validity is the approximate truth the inference is made regarding the study that involves a causal relationship (Trochim, 1999)

Reliability is a necessary ingredient for determining the overall construct validity of a research and enhancing the strength of the results. Kirk and Miller (1986) identified three types of reliability in quantitative research, which relates to:

- the degree to which a measurement, given repeatedly, remains the same
- the stability of a measurement over time

- the similarity of measurements within a given time period

Due to the positivist roots of reliability and validity concepts, there is no singular opinion amongst the researcher of how these terms should be presented in the qualitative research. Some of them believe that reliability is a concept used for testing or evaluating quantitative research, but the most important test of any qualitative study is its quality; this is also can be called as the concept of good quality research, where reliability is a concept to evaluate quality in quantitative study with a "purpose of explaining" while quality concept in qualitative study has the purpose of "generating understanding" (Stenbacka, 2001, Eisner, 1991). According to Stenbacka, (2001), "the concept of reliability is even misleading in qualitative research. If a qualitative study is discussed with reliability as a criterion, the consequence is rather that the study is no good".

Others believe that validity and reliability are two factors, which are affecting the main phases of the qualitative research such as designing a study, analyzing results and judging the quality of the study. It is stated that the quality of a study in each paradigm should be judged by its own paradigm's terms (Healy, Perry, 2000, Patton, 2001)

The compromise was found in the field of validity and reliability testing or maximizing. Golafshani argues that triangulation is typically a strategy (test) for improving the validity and reliability of qualitative research or evaluation of findings. Mathison (1988) elaborates this by saying: "Triangulation has risen an important methodological issue in naturalistic and qualitative approaches to evaluation (in order to) control bias and establishing valid propositions because traditional scientific techniques are incompatible with this alternate epistemology".

Triangulation let to achieve validity by combining different methods. Triangulation may include multiple methods of data collection and data analysis, but does not suggest a fix method for all the researches. The methods chosen in triangulation to test the validity and reliability of a study depend on the criterion of the research.

Triangulation is the main concept used in the current research; in order to achieve the validity and reliability, both kinds of data were collected: as primary, derived from interviews and case study, as secondary received by observation of preliminary researches and secondary data sources such as internet, publications, etc. To prove the reliability of the research, the case study was used as an illustration of conclusions made by the interviews analysis.

Interviews are the most vulnerable part of the research concerning the validity and reliability. Threats to the validity exist at each of the gaps between informants' experience and researcher conclusions. Such gaps as misperception or selectively perception or misunderstanding the situation

from both sides as researcher and interviewee can be solved by applying of the triangulation method. In order to get reliable and valid information, interviews were held with the senior managers of different interesting companies.

In order to achieve the validity, bearing in mind the aim of study "Economic feasibility of the Northern Sea Route container shipping development" current research is tended to be a contribution of knowledge about processes and tendencies derivative inside the NSR and its development. Triangulation of interviews, case study and observation of secondary data and statistics is aimed to maximize the validity and reliability of research, to clarify the current condition of NSR, to make predictions and prognoses about the future state of NSR.

2.4. Summary

This chapter was aimed to uncover the scientific methods which were used during the research. It was found out that the most appropriate philosophical approach to the research devoted to economic feasibility of development and using of Northern Sea Route is relativism. Thus in the research different sources of information should be used and then the conclusion will be triangulated. The most common way of gathering information for a relativist approach is interviews. At this research interviews will be used as sources of qualitative information.

The whole study will consist of the following parts, the choice of which, were made according to philosophical paradigm:

- Study of the theoretical background about the subject and secondary data collection;
- Designing and providing the interviews of the parties interested in the development of the Northern Sea Route;
- Hermeneutical analysis of the collected data, performing trend analysis;
- Modeling and solving a case study, based on analysis results, and concluding about the economic feasibility of the route. The case study will be modeling the situation, when the Northern Sea Route is already in use and calculate the economic feasibility of using it for a certain freight company. The case study will analyze the possibility to use new type of ice-breakers.

The validity will be achieved by contributing knowledge about processes and tendencies of the Northern Sea Route development. The validity and reliability will be maximized by triangulation of interview data, case study, implementing secondary data and statistics. All these

methods will help to clarify the current condition of NSR development, find some trends and make forecasts for the future use of Northern Sea Route.

3. Theoretical Background

This chapter contains the theoretical framework which is seems to be necessary to answer for the main question of the research: "Will the development of the Northern Sea Route lead to increasing of its economic feasibility?" First of all, it is necessary to explain what exactly is freight transport and its significance in modern life. After that the description of container shipping itself provides the important technical characteristics, defining such type of shipping. The necessary notes about coastline infrastructure for container shipping will be examined in subchapter "Ports". Then more scientific sides of the thesis will be touched upon the next three subchapters, which are urged to help to uncover if the suggested way of shipping is feasible or not.

3.1. Literature review

The theoretical and empirical background is derived mostly from the literature. It seems to be logical to mention several authors, which ideas affect the course of the current research study. First of all, it is necessary to start from the theoretical aspects and approaches used in the study:

- Tatum (2007): reveals the definition of the freight transport and enlighten the significance of it
- Tongzon (2009): argues that there are three typical groups of shippers
- Chou (2005): scrutinizes the determinants of port choice, discusses that three players can be considered in the container transportation market, as port administrators, carriers, and domestic shippers
- Maximov (2008):explains the relationship of the Russian government to PPP in transport sectors
- Cole (2005): signs six main factors that are determining the demand for transportation.

- Sandriev (2002): elucidates the general trends of governmental assistance in maritime transport

Though not every theoretical model was used in the research, but still it gave the strong empirical support. Then it is important to mention the studies which directed the authors in the case solution:

- Sasaki (2001): proposes the model of evaluation of economical and environmental impact

- Lui and Kronbak (2009): described the situation of potential economic viability of using the Northern Sea Route as an alternative route between Asia and Europe

- Verny and Grigentin (2009): reveals the cost of shipping one TEU on the Northern Sea Route

3.2. Freight transport and its importance

Cambridge Advanced Learner's Dictionary (2005) defines freight as “goods, but not passengers, that are carried from one place to another, by ship, aircraft, train or truck, or the system of transporting these goods”. So Freight transportation is the process of conveying different types of goods from one point to another using a variety of transport modes. The transport of freight can involve road solutions, air deliveries and even the use of waterways to move the freight from a point of origin to a destination (Tatum, 2007)

Freight transport and logistics are a pre-condition and at the same time a "consequence" of economic and social action. They are the backbone of the manufacturing industry that is characterized by division of labour. Efficient logistics systems and networks are therefore a key factor of success for businesses and business locations in international competition.

Freight transport, or shipping, is a key in the value chain in manufacturing (Chopra, Meindl, 2007). With increased specialization and globalization, production is being located further away from consumption, rapidly increasing the demand for transport. While all modes of transport are used for cargo transport, there is high differentiation between the nature of the cargo transport, in which mode is chosen (Bardi, et al., 2006).

Road freight is mainly in the transport of cargo units by means of roads by truck. The main advantage of road freight is that it helps to deliver the cargo to almost any place on earth, but is consumes a lot of energy, due to the fact that quite small cargo (in comparison to other modes of transportation) can be delivered at a time. Despite of that fact, using a truck and roads are still the only alternative to deliver cargoes to many places in the world, which do not have open water and railroads nearby.

A freight train is a group of freight cars (US) or goods wagons (UIC) hauled by a locomotive on a railway, ultimately transporting cargo between two points as part of the logistics chain. Trains may haul bulk, intermodal containers or specialized cars. Rail freight often causes high transshipment costs and is not as flexible as the road the sea, but allows using economy of scale, due to the fact that trains can transfer tens of thousands of tonnes per one voyage.

Air freight has become more common for products of high value; while less than one percent of world transport by volume is by airline, it amounts to forty percent of the value. Time has become especially important in regards to principles such as postponement and just-in-time within the value chain, resulting in a high willingness to pay for quick delivery of key

components or items of high value-to-weight ratio. (Chopra, Meindl, 2007). In addition to mail, common items send by air include electronics and fashion clothing.

The last possible mode to deliver a cargo is to freight a ship. The main advantages of water-borne transport for both national economies and for the environment are its unrivalled low overall economic costs and the additional function of waterways as an environment for living and recreation. (Waterborne transport. Federal Ministry of Transport, Building and Urban Development of Germany, 2009). Sea transport has been the largest carrier of freight throughout recorded history. Ship transport can be over any distance by boat, ship, sailboat or barge, over oceans and lakes, through canals or along rivers. Ship freight has huge potential for economies of scale, because, for example, supertankers can reach sizes of 550,000 DWT. The main disadvantage of such mode of transportation is that you are not able to implement it to cargoes, which are critical to delivery time, because the sea trip may last more than a month (E.g. from China to Rotterdam along the South African coast).

3.2.1. Modal choice

Choice of particular mode and routes between two points is an essential element of meeting a transport demand. It requires an investigation of the basic economic and service characteristics of the available transportation modes and routes, such as capacity, costs, and performance of the existing or proposed transport system. It is obvious, that the choice of the best particular mode or combination of modes will minimize costs or maximize utility.

In spite of that, a mode may have higher directly assignable costs for performing a transport service, but the savings on handling, packaging, inventory, and other distributional costs may compensate that or even more. Though, Meyer and Straszheim (1997) believe that this may be difficult to model.

According to the report of Mathisen et al.(2009), there is the following dependence between the cost per ton and the distance. The functions are calculated for each route and showed in the figure below.

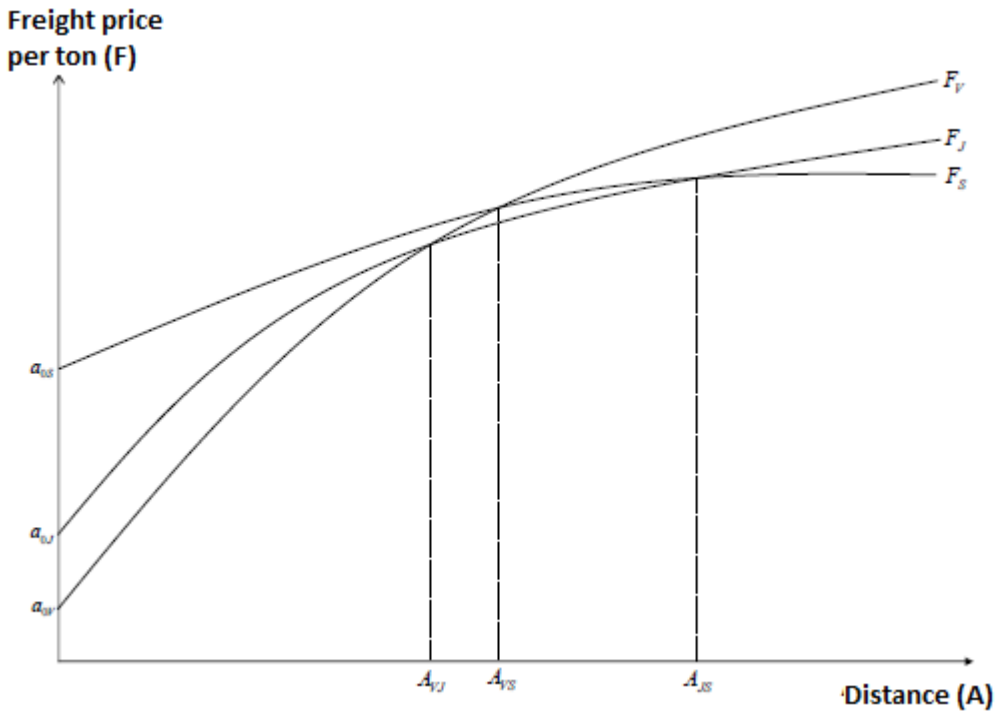

Figure 3.1: Possible dependences between transport cost and transport distance for different transport modes (Mathisen et al. 2009).

At this graph F_V, F_J and F_S are the dependences between distances and feasible freight prices per ton for road, train and sea freight relatively. The initial investments per ton for each mode are a_{0V}, a_{0J} and a_{0S}.

The choice of the mode is strongly dependent on the distance. If the distance is comparably short, the truck mode should be chosen. From some certain point (A_{VJ}) the train usage will be more efficient. The sea freight is the most appropriate mode for very long distances (from A_{JS} and longer), due to the larger economy of scale, which did not allow the shown function to grow faster, despite the fact of higher initial costs.

3.3. Container shipping

Although having its origins in the late 1780s or earlier, the global standardization of containers and container handling equipment was one of the important innovations in 20th century logistics. Nowadays ISO standardized containers are used for the most part of freight transportations in the world. This kind of freight is also called intermodal freight, due to the fact that it involves the transportation of freight, using multiple modes of transportation (rail, ship, and truck), without any handling of the freight itself when changing modes.

There are five common standard lengths, 20-ft (6.1 m), 40-ft (12.2 m), 45-ft (13.7 m), 48-ft (14.6 m), and 53-ft (16.2 m). An equivalent unit is a measure of containerized cargo capacity equal to one standard 20 ft (length) × 8 ft (width) container (Levison, 2008). As this is an approximate measure, the height of the box is not considered.

As you can read before, containers are intermodal mean of transportation and can be carried by trucks, trains, airplanes and ships; but the container transportation by ships has the largest scale. Containerization has revolutionized cargo shipping. Today, approximately 90% of non-bulk cargo worldwide moves by containers stacked on transport ships; 26% of all containers originate from China (Ebeling, 2009).

Containers are usually shipped by special container ships. First container ships were converted tankers, but in 1956 the first purpose-built container ship was launched (Levinson, 2006). Container ships are designed in a manner that optimizes space. Capacity is measured in Twenty-foot equivalent unit (TEU). Above a certain size, container ships do not carry their own loading gear, so loading and unloading can only be done at ports with the necessary cranes at specially designed container terminals, that are used to transfer containers from ships to trains or trucks for onward transportation. However, smaller ships with capacities up to 2,900 TEU are often equipped with their own cranes.

Using the intermodal freight transport is very important for the world economies, because it reduces cargo handling, and so improves security, reduces damages and losses, and allows freight to be transported faster. Containerization, with the standardization of ISO containers on all vehicles and at all ports, has revolutionized international and domestic trade, offering huge reduction in transshipment costs. Traditionally, all cargo had to be manually loaded and unloaded into the haul of any ship or car; containerization allows for automated handling and transfer between modes, and the standardized sizes allow for gains in economy of scale in

vehicle operation. (Bardi, et al., 2006). The largest economy of scale can be achieved by using container ships. Economies of scale have dictated an upward trend in sizes of container ships in order to reduce costs. One limit on ship size is the "Suezmax" standard, or the largest theoretical ship capable of passing through the Suez Canal, which measures 14,000 TEU (Vessel Size Groups, 2000).

Despite of the positive sides of using the containers for shipment, there are some disadvantages of such a method. For example, the use of containers causes the extra fuel expenditure and reduces the capacity of the transport, because the container also must be shipped, but not the goods. Secondly, containers should be used constantly, but there is not always an opportunity to fill up the unloaded containers, so some extra costs appear for transporting empty containers back. At third, Containers occasionally fall from the ships that carry them, usually during storms; it is estimated that over 10,000 containers are lost at sea each year (Podsada, 2001). Most go overboard on the open sea during storms but there are some examples of whole ships being lost with their cargo (Freak waves spotted from space, 2004) When containers are dropped, they immediately become an environmental threat — termed "marine debris".

3.4. Ports

The world economy globalization is the main reason of increasing cargo flows all over the world. This situation is the basic driver in container terminal operations and land transportation. Container ports are breaking points in the intermodal transport chain (Franke, 2008). Containerization has expanded to a global transport system with efficient 6000-8000 TEU vessels, large high-tech terminals, intermodal, inland transportation and computerized online information systems (Rijsenbrij, 2008).

3.4.1. Trends affecting the port development.

It is said that volume of container shipping will continue to grow; Risjenbrij (2008) supposed that from 2000 to 2010 the worldwide annual growth could range about 5-7 percent per annum.

The increase in volumes of turnover, vessel sizes and demand of faster service and better facilities stimulate the development of larger and faster container terminals. And there are a lot of questions which are arisen, for example:

1. How to design and construct the quay?
2. Which gate systems to handle the inland flows in a secure way?
3. What types of container cranes will be necessary?
4. What kind of automation system to adopt for providing unceasing handling?

But the main question, which is general for all stakeholders (terminal operators, port authorities, governments and inland transportation companies), is "What future scales can be expected, both for vessel sizes and inland transport vehicles?" (Rijsenbrij, 2008)

The trends in global container logistics market and demand of shippers will affect the future port developments. Shippers are requiring better service level, guaranteed service times for the delivery and receival of containers, sufficient flexibility in case of peak demand.

The increasing awareness of control over imported cargo entering the countries dictates the required inspections, such as X-ray, visual inspection, product tests (Rijsenbrij, 2008). This leads to additional transportation of cargo to the special facilities inside the port territory. The increasing demand for port facilities can cause an increasing scarcity of land for port operations, such as terminals, and increasing land value (Weigmans et al, 2008). This situation can lead to

development of satellite terminals, which will help to achieve a better utilization of mainport facilities.

Quality is very important for answering all the customer needs and demand in the container terminal handling market. A good network position and well-organized processes go on the back side while meeting customer needs and delivering high quality for low costs are becoming dominating in port choice.

3.4.2. The choice of ports and terminals

In Europe and Asia container carriers do have choices between different container ports. It is obvious that the choice of ports depends on shippers decisions. Shippers can be descried as consignee and consignors. According to Tongzon (2009), shippers can be divided into three groups:

1. those who have long-term contracts with shipping lines (they are committed to a particular carrier for a number of years and are therefore dependent on the shipping lines' chosen port of call);
2. those who are using freight forwarders (they delegate the responsibility for port selection to the freight forwarders);
3. those that are independent shippers.

As it can be seen, only the freight forwarders and the independent shippers are really the decision makers in port selection choice. Considering the aspects which the potential customer examines before making a choice, the port administration and terminal operators can take the measures to resist the growing competition.

Determinants of port choice can be presented as two main basic types: qualitative and quantitative. The first one considers the route factors, cost factors and service factors (D'Este and Meyrick, 1992) and they could be measured and compared.

Qualitative factors can not be objectively measured and imply such aspects as flexibility and ease of use, the port's marketing efforts, tradition, personal contacts and the level of cooperation that may be developed between the shipper and the port, previous experience, etc (Tongzon,2009).

There are few studies scrutinizing the determinants of port choice, but Chou provided interesting information about this problem. Chou et al. (2003a) discussed that three players can

be considered in the container transportation market, as port administrators, carriers, and domestic shippers.

Looking on this problem through the game theory approach, this situation leads to Stackelberg model (Chou, 2003, Yang, 1995,1996,1998,1999). The model is used to explain the behavior of shipping companies and shippers.

Port administrators can be regarded as superior players, because they have complete information about the optimal behavior of both carriers and domestic shippers under given port management policies. Carriers, on the contrary, can be regarded as superior players to shippers, because carriers have complete information about the optimal behaviors of shippers under given carriers' services (Chou, 2005).

The relationships between players is shown in figure below (Chou, 2005):

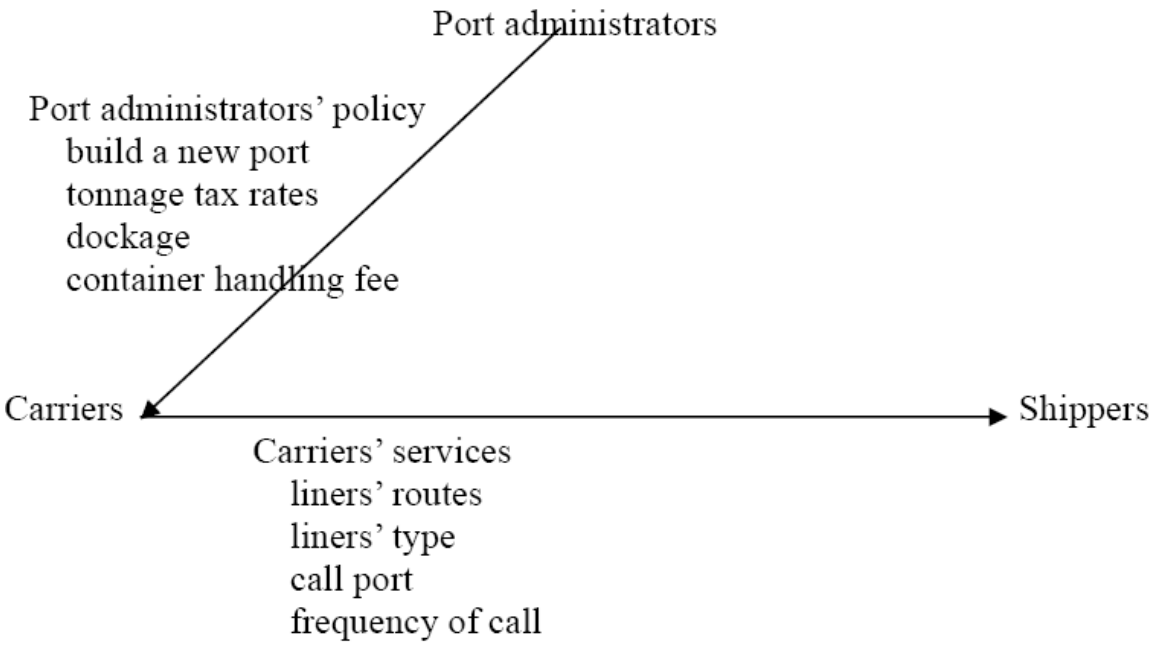

Figure 3.2:Relationship between Port administrators, Carriers and Shippers in Stackelberg Model (Chou, 2005)

using his strategies of routing, vessel type, call port and frequency of call on each route (Chou, 2005). While making these strategies, the carriers should take into account all information concerning the behaviors of shippers.

As it was said above carriers have complete information about domestic shippers. For this reason carriers can be regarded as leaders and domestic shippers can be regarded as followers in the foreign trade container transportation market (Chou, 2005).

Domestic shippers may choose their port to minimize the total transportation cost under a given liner service (Chou, 2005).

Chou (2005) suggested the following structure of port choice according Stackelberg model:

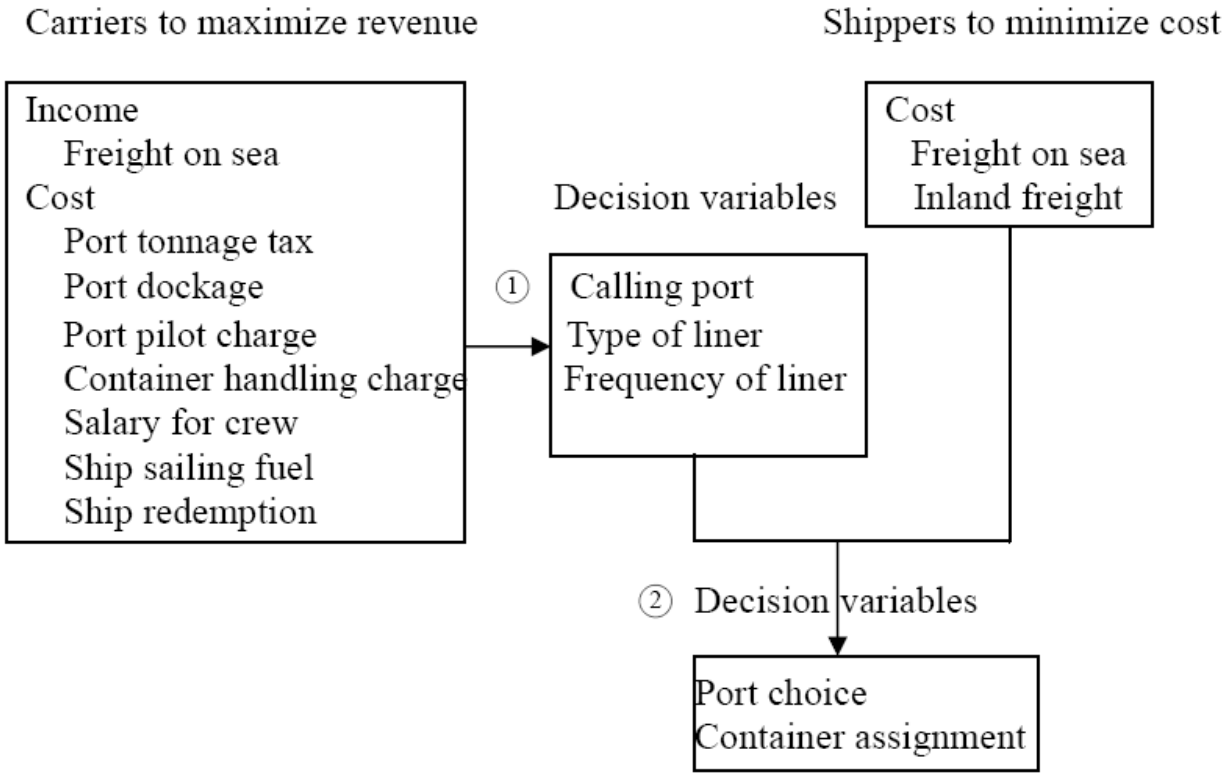

Figure 3.3:Structure of Stackelberg Model for Port Choice (Chou, 2005)

These schemes reflect the main aspects that affect the customers choice.

However Tongzon (2009) generalized these into several main groups of determinants of port choice. They can be presented in the table below:

Frequency of ship visits	Offers more opportunities in scheduling shipments and selecting a shipping service for the transportation of cargoes, and hence resulting in more competitive carrier costs, also, allows for greater flexibility and lower transit time. Thus, the more ship visits a port has, the more attractive it is to shippers.
Port efficiency	means speed and reliability of port services, can be reflected in the freight rates charged by shipping companies, in the turnaround time of ships and cargo dwelling time, two main categories identifying the port efficiency are operational efficiency measures (deals with capital and labor productivity as well as asset utilization rates) and customer-oriented measures (direct charges, ship's waiting time,

	minimization of delays in inland transport and reliability) (Tongzon, 1995).
Adequate Infrastructure	the number of container berths, cranes, tugs and terminal area, the quality of cranes, quality and effectiveness of information systems, availability of inter-modal transport (such as roads and railways), the approach channel provided and the preparedness or otherwise of the port management (Tongzon and Ganesalingam, 1994)
Location	the better the geographical location is, the lower the overall transit costs of cargo trafficking
Port charges	generally levied on the basis of port visits and/or cargoes, include port navigation fees, berthage, berth hire, harbour dues and tonnage while cargo-based types include wharfage and demurrage; berth hire and berthage are usually levied either on the basis of net registered tonnes or against gross registered tones; stevedoring and terminal handling charges are levied on cargoes with different rates for different cargoes; direct port charges may eventually be reflected in the freight rates shippers have to pay, other types of costs which shippers eventually pay include ancillary charges such as costs of pilotage, towage, lines, mooring/unmooring, electricity, water and garbage disposal (Tongzon, 2002).
Quick response to port users' needs	constantly monitor and understand the needs of port users in order to devise the quickest way to respond to them
Port's reputation for cargo damage	marketing and promotional efforts by port authorities to highlight the port's positive characteristics and accomplishments could improve the port's reputation

Table 3.1: Main groups of determinants of port choice (Tongzon, 2009)

The table above examines the main characteristics which are intrinsic to a good port from the shipper's point of view.

3.5. The Government's Role in Transport Sector

Maritime transport plays a crucial role in external economic relations of the country, which could not attract the attention of government. This situation demands a centralized management of this industry. However, such organizational structure of management is characterized by a high degree of fragmentation and decentralization.

State regulation of ports is considered as an important factor for increasing efficiency of operating port, contributing to the development of adjacent regions and the country as a whole. In some countries, the state policy of coordination provides even for competing ports in various areas of their business: pricing, investment policies, labor and material resources (Sandriev, D., 2002). This policy allows optimize the value of capital investments in their development and thus reduce transport costs.

Coordination and ensuring the priority of public interest in the ports can be implemented in different ways. The port can be controlled by a single government agency or private company, which rents the facilities and resources of the port (berths, warehouses, etc.) (Sandriev, D., 2002). In the latter case, the protection of national interests is realized through lease contracts. The greater the number of private firms and the greater the administrative status of the port, the greater the absolute power should be given to a coordinating body for the protection of national interests. These are two extremes in the management of ports.

In practice, recently the third type of management becomes more popular. It is called "Autonomous Port" (Boeuf, 2003). The status of the autonomous port authorities may be different. Their common feature is improvement of the port's commercial exploitation and the restriction of government intervention, except for selected areas with overall economic value (pricing, investment planning in ports and so on).

Independent port authorities rarely have complete freedom in establishing or changing the port charges. In most cases, the ports need to get permission for this from government. In some countries, the unions of small and large ports are running by standalone ports. In this case, the adoption of common policies (in pricing, distribution, cargo, capital, etc.) provides a more efficient operation of the whole group of ports (Boeuf, 2003).

The decision of granting subsidies to the port is solved in each country in its own way. There are separate ports in Western Europe which receive large subsidies from the state. In this case the level of port charges will be lower and this increase the competitiveness of the port, but

it reduces the incentive for the effective operation as for owners and for customers of the port. Subsidies can take many forms: soft loans, preferential prices for real estate, the release of the port from the national or local taxes, etc (Sandriev, D., 2002).

International experience shows some general trends. In general, private ownership of transport services is much more common than private ownership of transport infrastructure. Freight transport belongs to private property more often than the passenger transport.

3.5.1. Public-private partnership

Probably, the most popular definition of Public-Private Partnership is the one given by the UK Commission on PPP: "a PPP is a risk-sharing relationship between the public and private sectors based upon a shared aspiration to bring about a desired public policy outcome" (Boef, 2003).

According to Private-Public Partnership Handbook (2008), there are basic contract types of PPP for implementing of infrastructure projects:

1. concession - a private company takes over responsibility for state ownership enterprise management for a certain period, during which the company assumes significant investment risk;

2. divestiture (transfer of assets) - a private company buys stocks of public enterprises through property auctions, public sale or a program of mass privatization;

3. greenfield - a private company or joint public-private enterprise builds and manages a new infrastructure facility for a period specified in the contract. Infrastructural facility may return to state ownership after the expiration of the contract;

4. management contracts and leases - a private company takes over responsibility for the management of public enterprises for a certain period of time, while ownership and investment solutions remain in state hands.

5. Service contracts – public authorities hire the private sector for carrying out the specific service for a specified period of time, typically for 1-3 years. The private sector has no possibility to change the fees and charges for services estimated by

the public authority, because government remains the primary provider of services (Public-Private Partnership (PPP) Handbook, 2008).

3.5.1.1. Russian Federation regulations about PPP

Global trends and experience of the same difficulties in the construction of Russian transport infrastructure (such as insufficient budgetary funding, required for ensuring the development of transport complex for growing Russia's economy), force Russian Federation to use the mechanism of private investment in transport projects. The transport, along with other infrastructure industries, is an important tool for achieving social, economic, foreign- policy goals and provides the basic conditions for the society.

The main tool to attract extra investment to the implementation of major infrastructure projects is the institution of public-private partnership. The most flexible and efficient form of PPP is seemed to be a concession, under which the private partner (the concessionaire) is involved in creation or upgrading of infrastructure, and then the concessionaire gets the facility for its long-term operational management to return the embedded investments.

In 2005, Russia adopted the Federal Law "On Concession Agreements ", which paved the way for the implementation of PPP projects in many areas of public sector, including transport, energy, education, health, utilities. Also RF government adopted Resolution "On the Investment Fund of the Russian Federation", which identifies the public financing order of PPP projects. State support is available for investment projects with national importance implemented by Public-private partnership, directed on (Maximov, V.V., 2008) :

1. socio-economic development of the Russian Federation with regard to creation and (or) development of infrastructure, which has national importance or which is necessary to perform in accordance with intergovernmental agreements obligations of the Russian Federation on creation of objects;

2. the establishment and (or) the development of Russian innovation system elements;

3. ensuring the implementation of institutional reforms.

According to Maximov (2008), provision of government support may be assigning in following forms:

1. co-financing of the investment project and registration of Russian Federation ownership, including costs of investment projects management, and also financing the development of project documentation;

2. direction of funds to the authorized capital of legal entities;

3. providing Russian Federation guarantees on investment projects, as well as other prescribed budget legislation means for securing commitments, which are in competence of the Government of the Russian Federation.

3.5.2. The general trends of governmental assistance in maritime transport

3.5.2.1. Navigation infrastructure.

Almost everywhere responsibility for provision and maintenance of normal navigation infrastructure, such as waterways, navigation facilities and means of navigation channels security rests on the state. This is partly directed to traditional notions of "freedom of navigation", in part - to the difficulties of charging direct consumer fees; PPP is very rare in this area (Sandriev, D., 2002). At the same time, many functions such as dredging, provision and maintenance of navigational funds, may be transferred to private companies by concluding of contracts. Furthermore, private companies can also act as suppliers of individual autonomous objects (for example, new shipping locks) and recover costs through user fees.

3.5.2.2. Port infrastructure.

Public ownership of port infrastructure is quite common in all countries of the world. For major public ports, banks prefer the rental model. In this model, the government acts as a corporatized landlord of the port, which is under commercial management. State landlord does not provide stevedoring services to shippers; it is responsible for the maintenance of canals, piers, utilities and public facilities (eg, intra-roads) (Sandriev, D., 2002). However, many of these functions such as tow, the keeping of berths, etc, may be transferred to private companies by concluding of contracts.

The banks also support the transfer of ports to private ownership, because competition between ports is useful when it has the long-term character. In cases when private investments depends on receiving of exclusive rights, the procedure of granting such rights is necessary to be fair and transparent, it has to be formed due regulatory framework.

3.5.2.3. Stevedoring services.

Within the bounds of the port rental model stevedoring services are provided by the private sector. This requires the establishment of a number leasing, concession or proprietary structures (Sandriev, D., 2002). If freight turnover allows, competition between stevedores is welcome. Banks do not exclude the possibility of the financial support to existing state stevedores in ports that have an effective and sustainable business model activity, tested in practice. Such support may also be provided to state stevedores that operate on a temporary basis in preparation for the advent of the private sector and the implementation of competition.

3.6. Transport Demand

The transportation demand and factors that influence it are very important, because that is the force that stimulates the building of supertankers and 7-kilometres trains.

Demand for transportation is not similar for goods demand, because, with the exception of few cases, transport is not in demand for its own characteristics, and just appears as a mean for achieving something else. Demand for public transport, road freight facilities or cargo shipping is usually derived by some other function, than the demand for food or clothes.

The demand for transportation is determined by, for example, manufacturer, who needs to transfer goods from the factory to the store or a warehouse, so usually the transport itself is not the product demanded. That is one of the objectives of a transport operator to establish a demand pattern for its service. It also has to relate its prices to the perception and consequent demand of its customers, and derive a pricing policy and a development or operating strategy for the transport operation which will optimize the use of the fleet (Cole, 2005).

Stuart Cole (2005) signs six main factors that are determining the demand for transportation.

First factor is the physical characteristics of the goods, which should be transferred. For example, the goods, which require urgent and guaranteed delivery (food with short shelf life or precious metals and jewelry) are usually moved by air. But some low value goods, like coal, steel, other raw materials; or goods, which delivery are not so time critical (cars, heavy machinery), will be moved by rail or heavy tonnage ships.

Price of the transportation also influences the demand. The lower the price, the more people are likely to demand the transport service offered (Cole, 2005). There can be only a few exceptions, like exclusive goods and services. Transport costs can influence the factory location as well. If the transport costs are low, the company will be able to launch a factory on a cheaper land, more distanced from the cities and markets, thereby more tonne kilometers will be operated.

The third factor can be the relative prices charged by different modes or different operators. This transfer of business between nodes or companies in passenger transport is determined to a large extent be the relative levels of fares on rail, bus, air services and the perceived costs of traveling by car (Cole, 2005). This effect is mostly noticed in passenger

transport, but in freight transport the effects of different prices are confidential to the hauler and client. However, that is obvious, that if few companies suggest the service of the same quality, the company with the lowest price is likely to get the contract.

The forth meaningful factor, that influences the demand, is the income of the passengers or the scale of companies-clients. As income increases so the amount of travelling for both business and leisure will increase. That is the reflection of the fact, that an individual, who has larger income, has more money he or she can spend on traveling on vacations. Also people with higher income are usually have a job with international connections, thus they have to make more travelling, connected with their business.

The speed of service likewise influences the demand and appears to be the fifth significant factor. It can be viewed from two sides. While watching from the side of a customer, reduced travel or shipment time means, that he should spent less working time in a journey, thus he or she will have more time for something more useful for him or her. Also that means fewer costs for a company that sends a person into business trip, because that person will be able to work more for the same "price".

From the operator point of view, the shorter trip time means that, there will be a possibility to make more journeys in 24 hours, so that increases the productivity of the vehicles. Thus the operation costs will reduce and an operator will be able to set a lower price, which can encourage the demand growth, and the increased productivity will improve vehicle availability to meet the higher demand without the need to purchase additional vehicles (Cole, 2005).

And, finally, the sixth key point is, of course, the quality of service. It can be divided into two sub points. First of all, the frequency matters. The departure times or arrival times must be adjusted due to the customers' requirements. Secondly, the service should be standardized.

Sometimes the quality of service becomes key marketing strategy, as it became, for example, for railways in northern Europe. The key points here are comfort, reliability and safety. Comfort means not only the reflection of living of the majority, but also easy-to-use registration system, waiting rooms, and other facilities.

Stuart Cole (2005) mentions that a frequent reason for loss of patronage by both passenger and freight carriers lies in the failure to deliver goods on time or to get passengers to their destination at the scheduled time. For example, French SNCF railways provided the high

patronage levels for themselves by the good timekeeping. Safety is also important for all interested parties (passengers/clients, government authorities and operators).

Any accident that becomes accessible for publicity attached to any mode of transportation may cause the demand reduction in short term, but the effect depends on many factors and the length of reduction period can not be exactly predicted.

3.7. Elasticity

An elasticity indicator in the context of modal choice defines the relationships between a percentage change in the level of an attribute and the percentage change in modal share, all other influences held constant. A direct elasticity relates an attribute of a mode to the same mode; a cross-elasticity relates an attribute to a competing mode's share (Hensher D.A., 2001).

The main distinction must be made between ordinary and conditional elasticities. The former measures the combined substitution and scale or output effect of a price change; the latter is similar to the compensated elasticity in the consumer demand theory and is conditional on the given level of output.

Distinction between the commodity demand and travel demand complicates the choice of the appropriate elasticity measure in the freight sector. Travel demand depends on the commodity demand, hence the demand for freight sector is derived from the demand of commodities being transported (Hensher D.A., 2001).

The elasticity of demand for shipping services varies from one commodity to another. An important factor affecting elasticity of demand for sea transport services is the cost of transport in relation to the market price of the goods carried. Branch (2007) revealed, that the cost of sea transport and associated expenses is often a considerable element in the final market price of many commodities; it may be between 8 and 15 %.

Also, it is necessary to mention the distinction between transport demand, usually measured in tones-km (tonnage transported times transport distance), and traffic, measured in vehicles-km (driven kilometers) (Beuthe,2000).

Transport market demand is relative to other sectors of the economy. It is important to distinguish the mode-choice elasticities and ordinary demand elasticities, because although aggregate choice-mode studies produce elasticities between modes but they do not take into account the price change on the aggregate volume of traffic (Oum et al., 1992).

3.8. Calculating economic feasibility

Arctic navigation is very dangerous and needs money, human forces and strong machinery to deal with cold, wind and ice water. Approximately 20 years ago the concept of Double Acting Ship (DAS) was developed and the first such ship was built. DAS is a type of icebreaking merchant ship designed to run ahead in open water and astern in ice. Such ships can operate independently in severe ice conditions without icebreaker assistance but retain better open water performance than traditional icebreaking vessels (Juurmaa et al., 2001).

Many of double acting ships are using ABB patented Azipod propulsion system. Azipod is a podded electric propulsion unit where the variable speed electric motor driving the fixed pitch propeller is in a submerged pod outside the ship hull, and the pod can be rotated around its vertical axis to give the propulsion thrust freely to any direction. Thus the ship does not need rudders, stern transversal thrusters or long shaft lines inside the ship hull.

Many ice tests not only model but also full scale show superior ice breaking capacity of DAS because of its lower ice resistance supported by pod-propulsion system (Sasaki et al., 2001). The It can be said that DAS has a possibility of saving an operation cost such as fuel oil consumption, ice breaker escort fee etc.

The saving in costs can make the use of such ships feasible for transit international shipping at the NSR, despite higher build price of DAS. During finding out the answer it is needed to calculate environmental impacts and operational costs for DAS and for usual containership, which sails through Suez Canal, and then the results should be compared.

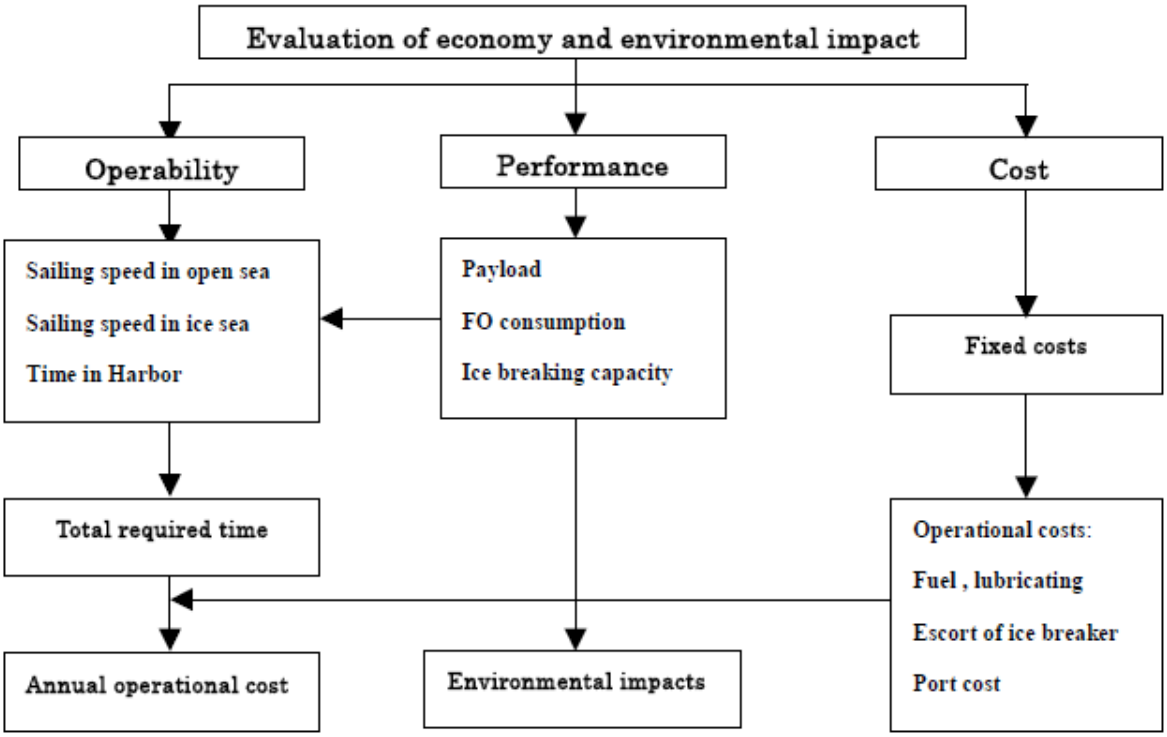

Figure 3.4: Evaluation of economy and environmental impact (Sasaki et al., 2001)

Total required time to sail in a route depends strongly on the climatic conditions. Therefore, the total required time to sail is not the same for one season to another season. For example, total required time in the winter season is longer compared with in the summer season due to ice.

Total required time to sail in a route is assumed summing up of required time in water condition, required time in ice condition and required time in harbor, which can be expressed as

$$T_T = T_{OW} + T_{IC} + T_H$$ (Sasaki et al., 2001)

Where, T_{OW} is required time in water condition, T_{IC} is required time in ice condition, and T_H is required time in harbor.

The length of the route between two points can be calculated as a length of a straight line between them, but as the total route is not a straight line, it should be divided into smaller parts, that will be assumed as straight lines, where the speed of the ship is constant. Thus the total time of the route can be calculated as following:

$$T_{AB} = \sum_{i=1}^{N} \frac{R_{AB}(i)}{V_{AB}(i)}$$

Where R_{AB} is a function, which returns the length for each i straight line with constant speed, and V_{AB} is returning the speed at i part of the route. This formula means, that it is needed to take the length of each straight line AB and divide it on the speed at that line, thus there is a sum of times needed for completing each straight line.

The time, needed for the whole route, if the route is partly covered with ice, can be calculated as following:

$$T = \frac{S_{ice}}{V_{ice}} + \frac{S_{open}}{V_{open}}$$

where T is time, S_{ice} is the length of ice-fields, S_{open} is the length of the area with open water, V_{ice} is the speed of the vessel in ice water and V_{open} is the speed за the vessel in open water.

According to Sasaki (2001), the calculation of required power is necessary for estimation of operational variable costs, which includes the costs of fuel and lubricating oil consumed, and for estimation of environmental impact. Required power depends on the ship bow shape a lot, because it determines the resistance of the ship, and can be calculated, using the following formula:

$$P = EHP/\eta = R_T * Vs/\eta \ (KW)$$

Where EHP is effective horse power and R_T is resistance of ship, and η is the coefficient of efficiency. All the values can be obtained from a model test in open sea condition.

As previous researches have shown, the wave resistance of DAS is approximately 10% higher than of an ordinary ship, but the propulsion efficiency of ABB Azipod aggregates is a little bit lower, than the efficiency of standard propulsion system. In spite of that fact, Increment ratio of cargo volume by re-arrangement of engine room will be 10-30% according to ABB Azipod references.

Talking about financial side, it is necessary to mention that a company, which will decide to buy ships for transportation through NSR, will not probably have enough money to pay the while price of the ships immediately, thus it will have to take a loan. When a loan is taken, the company

will pay certain sum annually to cover it and the interest rate. It is needed to calculate the amount of annual payments and total sum that will be paid to the bank.

The most typical loan payment type is the fully amortizing payment in which each annual rate has the same value overtime.

The fixed monthly payment *P* for a loan of *L* for n years and an annual interest rate *c* is (Guttentag, 2009):

$$P = L \cdot \frac{c\,(1+c)^n}{(1+c)^n - 1}$$

3.9. Summary

To summarize, it was emphasized that freight transport is a key of the value chain in manufacturing and the significance of this key can be measured. The main indicators of such measurement are transport demand and elasticity. Both of them are influenced on the calculating of the economic feasibility of the given transport route with the given type of transport. It was discussed the special features of using the double-acting ships as the primary type of vessel. This characteristic put the specific seal on the research, as the theoretical frame had shown.

4. Empirical Part

This chapter is devoted to the research with the empirical findings about the current state of the NSR and the future plans about its development. The main information of this chapter was collected from secondary data sources and supplemented with the results of 5 in-depth interviews. The answers of the respondents revealed what aspects of the research problem should be touched upon to make it clear.

This part starts from the historical background of the NSR development and follows by the description of current condition of the NSR, legal regulations and guidelines. Two types of guidelines for shippers, such as Russian mandatory guidelines and IMO non-mandatory guidelines, will be compared. After that the several details of infrastructure would be considered, such as the conditions of ports and the icebreaker assistance.

After the information about the NSR itself, the experience of using it will be examined from foreign (the experience of Beluga Shipping) and Russian sides. The chapter will be finished with a brief summary about what information will be acquired during the empirical study.

4.1. Historical background of NSR development

4.1.1. Discovery of new geographical areas

The Northern Sea Route development has a long, centuries-old history. At the early stages of opening Siberia native tribes navigate through western part of the present NSR. These brave pioneers have unique practical skills to perform long voyages in small, fragile vessels in extreme climatic conditions. In the XI century Russian explorers came to the seas of the Arctic Ocean, in XII-XIII centuries they opened Vaigach island, Novaya Zemlya, and at the end of the XV century the islands of Svalbard and Medvezjiy island were opened (NSR: the history of development, 2007).

It is considered that the first idea of the Northeast Passage wide use (the old name of NSR) for maritime traffic between Russia and China was expressed by Russian diplomat Dmitry Gerasimov in 1525 (Selin, Istomin, 2003).

Due the second half of the fifteenth century the Brititsh and Dutch navigators tried to pass the Northeast Passage. One of their main goals was the opening of a new trade route to China. The best known expeditions were led by Richard Chancellor and Hugh Willoughby (1553-1554), as well as Arthur and Charles Pet Jackman (1580) (NSR: the history of development, 2007). Usually they could achieve only Northern Dvina, the Murmansk coast and the New Earth.

At the end of the XVI century, Russian navigators began to make regular sailing to the gulf of the Ob River, and later to the Yenisey basin (NSR: the history of development, 2007). The opening of the last section of the North-East Passage is associated with the names of Semen Dezhnev and Fedot Popov (Burkhanov, 1958).

A significant contribution to the study of the eastern section of the Northern Sea Route was made by Russian navigators Wrangell and Matyushkin. In 1820-1824 they explored and mapped the mainland coast from the mouth of the Kolyma to the gulf of Kolyuchinskaya and made four trips in the drifting ice that had no previous analogues (NSR: the history of development, 2007).

4.1.2. The economic interest of NSR use

As far back as 1877 there were occasional expeditions with the intention of taking Siberian agricultural products and mineral resources over the Kara Sea to world markets. Only 75 trios of 122 were successful til 1919; they carried only 55 thousand tons of various cargoes (NSR. Review note, 2007). Failures of Kara expeditions are supposed to be connected due to the absence of proper system of navigation, ports, ice-breakers.

In 1899 admiral Makarov ordered the world's first powerful icebreaker "Ermak" in England, which is intended to be used for regular communication with the Ob and Yenisei rivers through the Kara Sea (Selin, Istomin, 2003).

The first evidence of possible use of the Northern Sea Route was expedition performed by Swedish scientist Nils Nordenskiöld on “Vega” in 1878-79; this voyage was the generalized experience of two trips on the streamers “Preven” and “Imer” through the northern sea route between Siberia and Europe in 1875 and in 1876 (NSR. Review note, 2007).

In the early twentieth century the development of the Northern Sea Route was one of the essential tasks of the Russian economy. In 1909, icebreakers “Taimyr” and “Vaigach” were built, they were intended for the systematic study of the Northern Sea Route (Burkhanov, 1958). In 1914, these icebreakers were sent to an expedition through the Northern Sea Route in a single

season. During the trip this problem had not been resolved; in October 1914, steamers encountered impassable ice, which forced the expedition to remain in the drift for the winter (Burkhanov, 1958). Only in September 1915, icebreakers reached Archangel, this ended the trip in two seasons.

4.1.3. The wide-use of NSR in the twentieth century

At the beginning of the twentieth century, a lot of attention had to be paid to the problem of NSR. The track between the gulf of the Ob and Yenisei gave a lot of opportunities to the army needs.

Lenin signed a decree about creating of the Floating Maritime Research Institute in 1921 (Burkhanov, 1958). The area of institute's research became the Arctic Ocean with its seas and the mouths of rivers, islands and bordering coastline. By 1933, there were built 19 radio-meteorological polar stations. Since that very moment the North-East Passage acquired its present name-Northern Sea Route (Selin, Istomin, 2003).

In 1932, the streamer "Sibiryakov" under the direction of O. Schmidt and Captain V. Voronin Boat passed the Northern Sea Route in a single season. Two more successful runs were made in 1933 and 1934. And after that NSR was officially open and commercial exploitation began in 1935 (Selin, Istomin, 2003).

Schmidt's success proved the possibility of active economic development in the Arctic. For practical realization of this possibility there was created the General Directorate of the Northern Sea Route (Northern Sea Route Administration). It supervised navigation, the depths of the polar areas, the organization of systematic research, the construction of meteorological stations along the coast, the development of radio, polar aviation, construction of icebreakers and ice-class vessels (NSR. Review note, 2007).

In 1933, to test the possibility of cargo ships sailing to the Arctic Ocean the steamship Chelyuskin was sent to navigate by the way of "Sibiryakov", it was headed by O. Schmidt and V. Voronin (Burkhanov, 1958). Unfortunately, the experiment was unsuccessful; the streamer sank, broken by ice. Since that, ships "Litke" and Baltic fleet warships, conducted by ice-breaker "Stalin" successfully passed the route from Murmansk to Vladivostok for a single season (NSR. Review note, 2007).

The Soviet Union became the first and the only country which uses the drifting polar station (Burkhanov, 1958). This is a complex of houses for researchers and the necessary equipment on the drifting ice floe.

By the beginning of Second World War Soviet Union had already gained considerable experience of cargo shipping in the Arctic; such reference ports of the Northern Sea Route, as Dixon, Igarka Dudinka, Tiksi, Pevek and Providence, were built.

In 1940-1970-s NSR became an integral part of national economy, providing life activities of Far North and Far East areas. They were provided by fuel, food and essential commodities, local natural resources were brought to the continent (Burkhanov, 1958).

In early 1990, the breakup of the Soviet Union and the socio-economic crisis of the former Soviet Union negatively affected the state of the Northern Sea Route. By 2003, the number of cargo transported by NSR was five times less (1.7 million tons) compared to period of its “economic prosperity” in the era of the Soviet Union. During this period, the largest volume of cargo transportation (65%) belonged to the company "Norilsk Nickel" (The Perspectives of the NSR development, 2003).

Today Russian Federation starts a number of serious practical measures for further development of NSR. In the first place it is connected with the development of the oil and gas fields in the Arctic shelf. Great importance has also the development of transit functions of NSR. It continues to play an important role for the development of the Far North and Far East. Many countries interest in the development of the new transport route from Europe to Asia, so NSR acquires not only the national interest for RF, but also the international interest.

4.2. Russian Federation Regulations of NSR

4.2.1. The historical framework of NSR governance

The first organization, which was aimed to explore the possibilities of shipping in the Arctic and their further practical use, was the Committee of the Northern Sea Route. It was established in the 1918-1919 by the Council of Ministers of the Provisional Siberian Government (NSR. Review note, 2007). Committee's main task was the creation of a sustainable maritime communications for the development of foreign trade between Siberia and Western European ports in the Arctic Ocean.

In 1920, this organization was transformed into Komseverput by the decision of the Siberian Revolutionary Committee; then this agency was reorganized into the North-Siberian State Joint Stock Company "Komseverput" in 1928 (NSR. Review note, 2007). In 1932 it became the All-Union export-import, transport and industrial association.

In 1932, expedition of the icebreaker Sibiryakov led by Schmidt first went through NSR from Arkhangelsk to the Bering Strait for a single season (NSR. Review note, 2007). As a result of this expedition, Soviet government reported on the possible development of industry and infrastructure of the northern part of the USSR. For this purpose, it was decided to create a single organization that would deal not only with the development of the transport system, but it also would deal with industry, northern fisheries, construction of port facilities, the organization of continuously operating radio and meteorological stations, building hospitals and schools for the local population.

In 1932, General Directorate of the Northern Sea Route under the Council of People's Commissars was established (NSR. Review note, 2007).

4.2.2. Present status of NSR governance

Today NSR is managed by the state legal agency such as Administration of NSR under Federal agency of marine and river transport of RF Transport Ministry.

The development of NSR is determined by the state legal aspects, such as (NSR. Review note, 2007):

1. Constitution of Russian Federation

2. Federal law about the basics of state regulation of social-economic Northern regions' development in RF
3. Concept of state support of Northern regions' economic development
4. Shipping politics of RF
5. Federal target programs, such as "World Ocean", "Modernization of RF transport system", "Maritime doctrine of RF for a period till year 2020"
6. Other legal acts.

K. Eger said: "*Russian guidelines set down all the mandatory requirements that ship-owners should know about the technical standards, technical requirements, fees, how do the Russian marine operation inspects ships before they enter the NSR and etc. They are the basic legal framework for international companies, sailing through the NSR*".

Development of the Arctic marine transport system serving NSR is an essential part of the Russian national policy in the field of transport. NSR is defined as an essential part of infrastructure and economic complex of the Far North, which links the inland waterways of Siberia into a single transport system of the Russian North (The restoration of NSR as the development urge for Arctic coastline, 2009).

Mr. Rautio said about the necessary measures for development of the NSR as the international trading route: "*The RF is in my understanding already working hard for opening the NSR, particularly through the Ministry for Transportation and the NSR-offices as well as the "Non-commercial partnership for the NSR usages". But this is only a beginning, the cost is today very high and many formalities and practicalities*".

Active exploration and development of oil and gas fields on the coast and continental shelf of the Russian Northern and Far-Eastern regions, development of new fields: all of these factors will lead to a significant increase of freight traffic in the Western Arctic area (NSR. Review note, 2007).

Efficiency and safety of the NSR vehicle fleet of Russia depend primarily on the icebreaking services. It requires 9-10 years for the design and construction of a new generation of nuclear-powered icebreaker. The first icebreaker of a new-designed type LK-60YA will begin its work by 2016; it is supposed to be a substitution for ice-breakers such as "Arctic" and

“Taimyr” (Arctic.NSR, 2009). According to the calculations of Maritime Board, the cost of building icebreakers is estimated at 11-12 billion rubles (Arctic.NSR, 2009).

In order to optimize the cost of construction and maintenance of a future nuclear-powered icebreaker fleet of new generation; new ice-breaker should be universal and able to work both at sea and on the route from Yenisei River to the port of Dudinka. Prior to 2021 at least three universal nuclear icebreakers must be built (Arctic.NSR, 2009).

Today, NSR provides the shipping support by following services (The concept of NSR development, 2009):

1. Rescue fleet
2. Nature conservation fleet
3. Linear, auxiliary and port ice-breakers
4. Buoy and hydrographic boats
5. Marine ports
6. Coastline sector objects
7. Navigate-hydrographic, hydro-meteorological, aircraft provision
8. Radio-connection
9. Survival services
10. Provision and technical service of fleet
11. Administrative agencies: Administration of NSR, naval staff, agencies of Murmansk, Far-Eastern ice-breakers fleet
12. NSR transit operators of Murmansk, Northern, Arctic, Far-Eastern, Primorsk shipping and also of “Lukoil- Arctic- Tanker” shipping.

4.2.3. Maritime doctrine of the RF for a period till year 2020

In 2001, the main plans about reconstruction and development of Russian waterways were stated in governmental document “Maritime doctrine of the RF for a period till year 2020”, signed by the former president of the RF V. Putin. The document defines the main goals, aimed

on the realization of measures, which are necessary for exploration, development and use of the oceans in the interest of safety, sustainable economic and social development of the RF.

"Maritime Doctrine of the Russian Federation is the fundamental document defining the state policy of the Russian Federation in the field of maritime activities" (Maritime doctrine of the RF for a period till year 2020, 2001).

The development of the NSR undoubtedly leads to the implementation of the new legal regulation acts. In accordance with the words of A. Jørgensen-Dahl, when he was talking about Beluga Shipping and its acquired experience during their project "Commercial Transit of the Northern Sea Route", that this experience should be evaluated as a guidelines for what should be done and changed in the Russian bureaucratic.

He said: *"Beluga had passed through numerous offices: in Moscow, regional, local and all over the place,- before they got the permission to go through. They were not sure which office or which institution they ought to go next".*

Mr. Stolberg confirmed that: "*It was some hundreds of pages though literally only one official application for entering and transiting the Northern Sea Route which went through the hands of the Russian Government, the Ministry of Defense, the Ministry of Agriculture and the Russian Secret Service plus the regular inspections of the MV "Beluga Fraternity" and the MV "Beluga Foresight" by port and custom authorities in Vladivostok*".

Mr. Jørgensen-Dahl believes that the problem of difficult and long process of permission gaining is in decentralization of regulatory agencies.

He argued: *"Russia is a big country. It has regions, municipalities, localities, central government, etc, and there are institutions at all these levels, that have some sort of influence on the running of the NSR. The problem is that it is decentralized that it is difficult for shippers to find the right way of approaching and the right institutions to go first. It is even necessary to get permission from prime-minister Putin".*

According to the Maritime Doctrine of the RF (2001) implementation of the national marine policy in the Arctic provides solutions to several long-term tasks, such as aspects of defense sector, logistic and administrative sides of the NSR development.

This assertion is supported by the statement about necessity of solving the long-term objects, which are detailed in the Doctrine, such as (Maritime doctrine of the RF for a period till year 2020, 2001):

1. Protection of the sovereignty, sovereign and international rights of the RF in the Arctic regional direction;
2. Creation of conditions for the activities of the Northern Fleet in the Barents, White and other Arctic seas of NSR;
3. Accounting of defense state interests in exploration and development of bio-resources and minerals in the exclusive economic zone and continental shelf of the RF;
4. Ensuring of the national interests of the RF in respect of the NSR, centralized state management of the transport system, icebreaking services and the provision of equal access to interested carriers, including foreign;
5. Maintaining of the world leadership in the construction and safe operation of nuclear icebreaker fleet;
6. Consolidation of the RF efforts and resources for the development of Arctic shipping, marine and river estuaries corridors, northern deliveries of goods, creation of information systems, that provide these activities.

Currently the necessary steps to implement these tasks are taking. In order to integrate the NSR in the global transportation system, Transport Ministry of Russia is taking measures to consolidate the status of the Northern Sea Route as an independent Eurasian maritime transport corridor under Russian control.

The document gives a lot of consideration to the development of legal acts, aimed on consolidation of NSR as the reliable waterway. One of such acts is the Federal Law “About NSR”, which is under study yet.

4.2.4. Federal Law “About NSR”

In 2009, the legislative proposal “About the Northern Sea Route” was presented to the government of the RF as the new federal law (Chilingarov presented a bill about the Northern

Sea Route, 2009). Today, it is still waiting to be approved. The new federal law is urged to regulate the state governance of NSR and its administration.

The law was elaborated in the network of Maritime Doctrine by the A. Chilingarov. The law proposes the centralized governance of the transport system, icebreaking services, and providing a clear access to regulated terms of carriers, including foreign ones.

The main purpose of the bill is to reaffirm and clarify the status and legal regime of the RF Northern Sea Route, as well as operational measures associated with it to prevent and control pollution of the marine environment (The Federation Council is considering a bill about the Northern Sea Route, 2009). Under the bill, Russia's non-military and foreign vessels pass along the Northern Sea Route on the basis of the notice and application to the Authority and its confirmation (The Federation Council is considering a bill about the Northern Sea Route, 2009). Foreign warships and vessels, which are in government service, will be admitted to the Northern Sea Route only by special permission, obtained in a diplomatic manner.

In accordance with world practice, the bill examines the cost recovery mechanism for the maintenance and operation of the icebreaking fleet, acquisition and supply users with the necessary navigational, hydro-meteorological and ice data, forecasts and recommendations for safe navigation, etc. In accordance with international experience, the law allocates paying services along the Northern Sea Route. The pay shall acquit the costs of all the services, described hereinbefore (The Meeting of Council of Noncommercial Partnership of the Coordination of Northern Sea Route Usages, 2009).

4.3. Regulations and guidelines for navigation in ice-waters

From the very beginning of Arctic exploration every seaman was realizing the bet, he was making, when deciding to sail in ice waters of the High North. The risk of getting damage to health and the ship is also very high even nowadays. The weather conditions of Arctic waters are dangerous for machinery and human beings, but simultaneously the ecological system of Arctic is very vulnerable, and human impact may easily cause ecological disaster.

4.3.1. Rules for Navigation on the Seaways of the Northern Sea Route

While exploring Arctic sea routes, people were seeking the way to make the transportation at the High North safe for seamen and nature. In 1990, USSR Minister of Merchant Marine approved the Rules for Navigation on the Seaways of the Northern Sea Route. It was an obligatory guideline, which should be kept by all commercial vessels, passing through the NSR. This document was reviewed in 1996 and the final edition defined the following aspects of navigation:

1. The borders of the NSR
2. Types of vessel pilotage through the Route
3. The list of documents, required for passing permission.
4. Technical requirements and standards, applied to the vessels, which sail through the NSR.
5. The information about the fees for passage.
6. The way the ships are inspected before the passage through the NSR, etc.

Few more regulatory documents were released in 1996 in addition to these rules. They were Regulations for Ice-breaker and Pilot Guiding of Vessels through the Northern Sea Route and Requirements for the Design, Equipment and Supplies of Vessels Navigating the Northern Sea Route.

Regulations for Icebreaker-Assisted Pilotage of Vessels on the NSR define the procedure for submitting requests, organization of the pilotage, obligations and responsibilities of the Master of the vessel, the Master of the icebreaker and the pilot on the waterways of the NSR.

Requirements for Design, Equipment and Supply of Vessels Navigating the NSR are taking into account the particularly complex and hazardous navigational conditions on the NSR

and take as the target the securing safety of navigation and preventing marine environmental pollution from vessels. Particular requirements apply to the hull, machinery installations, systems and arrangements, stability and watertight integrity, navigational and communication facilities, supplies and emergency outfit, manning (Gorshkovsky, A.G., 2006).

The Research Fellow Karl Magnus Eger at Ocean Futures during a telephone interview named the Russian Guidelines the "*basic legal framework for international companies, which want or have to sail through the NSR*".

4.3.2. IMO Guidelines

In 2002 the International Maritime Organization (IMO) has released another "framework" for sailors in Arctic. The IMO Guidelines include general, construction, equipment and operational parts, subdivided into chapters. However these Guidelines are not mandatory for now, they have a notice included, that it should be right to make local navigation rules according to them.

Unfortunately, the Russian side did not make any changes to any of the three regulatory documents that were released in 1996. Karl Magnus L. Eger noticed that Russia did not try to implement the recommendations, set down in IMO Guidelines in 2002. Russian rules do not mention the certificates and education, which the pilots and seamen should have, but they are very important, when talking about the safety in ice waters.

However the IMO Guidelines are not ideal too. In 2007 Øystein Jensen examined the document and marked the aspects, which need further development (Jensen, Ø., 2008). He signs that current guidelines has some certain "shortcomings".

Mr. Eger considers: "*Today, the IMO guidelines has a lot of weaknesses. For example, there are requirements for ice-navigators in terms of education, considering no certificates, no modal courses for ice-navigators, operating in Arctic waters*".

First of all, internationally recognized and approved training course for ice navigators or qualification schemes for individuals who are to operate vessels in ice-covered waters do not exist. The paragraph 1.2.1 of current IMO Guidelines signs that all ships that are navigating in ice-waters should have at least one ice navigator. Paragraph 14.2 of the guidelines adds further that an ice navigator should have documentary evidence of having satisfactorily completed an approved training program in ice navigation. But these paragraphs are using very broad terms and are not signing the exact level of knowledge and skills of ice navigator.

Secondly, the guidelines also fail to provide sufficient regulation concerning icing (Jensen, Ø., 2008). While sailing in Arctic, when cold temperatures result in spray blown off the sea freezing immediately on contact with a vessel. If the ice is not removed on time, that may destabilize the ship and cause a disaster. This situation is mentioned in current guidelines but again in very general way. The certain measures of removing ice and the frequency of such a procedure should be sighed to provide the safety of a vessel.

These are just few points that need further development and improvement. The guidelines are permanently changing and complemented, thus in 2009 the new release of the annexed IMO Guidelines was approved. It was reviewed in respect to International Association of Classification Societies (IACS) guidelines, released in 2006 and called "Unified requirements for polar ships".

It is intended that application of the guidelines should be encouraged for all ship types and sizes, where appropriate, and should apply to existing ships as far as is reasonable and practicable, as well as to new ships. The Maritime Safety Committee also agreed to consider the further development of the guidelines in the form of a Code for ships operating in Polar waters, which could, eventually, be made mandatory.

Mr.Eger said: "*The IMO council currently discussed whether these guidelines should be mandatory for ships, operating in Arctic waters; or whether they should stay recommendatory, as they are today*".

Øystein Jensen (2008) marked that in a non-binding form, the guidelines' contribution to maritime safety in ice-covered waters seems rather limited. However, the ultimate practical impact of the regulations depends on actual application, and not merely on which legal status they acquire upon adoption in global and national forums.

4.3.3. Guidelines-comparison

Thereby there are two important frameworks, which should be taken into account while navigating through the NSR, to provide the necessary level of safety. The Russian Rules and IMO Guidelines have much in common, but the last was composed in compliance with international standards and interests, that is why a lot of experts are now recommending Russian side to revise the current rules.

From another point of view the Russian the Rules for Navigation on the Seaways of the Northern Sea Route are more specific, than IMO guidelines. They are dealing only with Arctic

and taking into account the governmental interest of Russia, claiming the Northern Sea Route a national transportation line.

It can be concluded, that both of these documents should be improved. IMO Guidelines should become more specific in questions of crew education and measures of accident prevention in ice-waters. The Rules for Navigation on the Seaways of the Northern Sea Route needs revision, due to the fact, that there were no edit since 1996, but the technology of shipbuilding is not standing still, as well as navigation systems. Climate changes and foreign interest of using the NSR as a trans-international transportation route should be noticed in the new edition of the Rules.

The NSR is a very difficult route for people, hull, techniques and constructions. The weather conditions and ice fields hamper the evacuation in case of emergency. This route comes through Arctic, which has very vulnerable ecosystem, and that is why any accident may cause ecological disaster. The consequences of such a disaster can not be easily redressed. Thus that is easier to try to avoid such accidents by following some rules, and these rules should be adequate, mandatory and common for everyone, who decides to use the NSR. Therefore, vessels are to navigate on the seaways of the NSR under reliable State control.

4.4. ***The Main Ports: Murmansk and Vladivostok***

Mr. Jørgensen-Dahl defines three types of shipping through the NSR as:

1. *"Destination arctic shipping (from starting point to port in Arctic itself; outside of the Arctic to local points)*
2. *Intra NSR shipping (between hubs along the NSR)*
3. *Transit shipping (from port of Europe to port of Asia, without the using of ports of NSR, but using the route itself)"*

In this research the transit shipping represents the greatest interest, that is why it is necessary to mention about two main ports. These ports are frontier for foreign ships, following from Europe to Asia and vice versa.

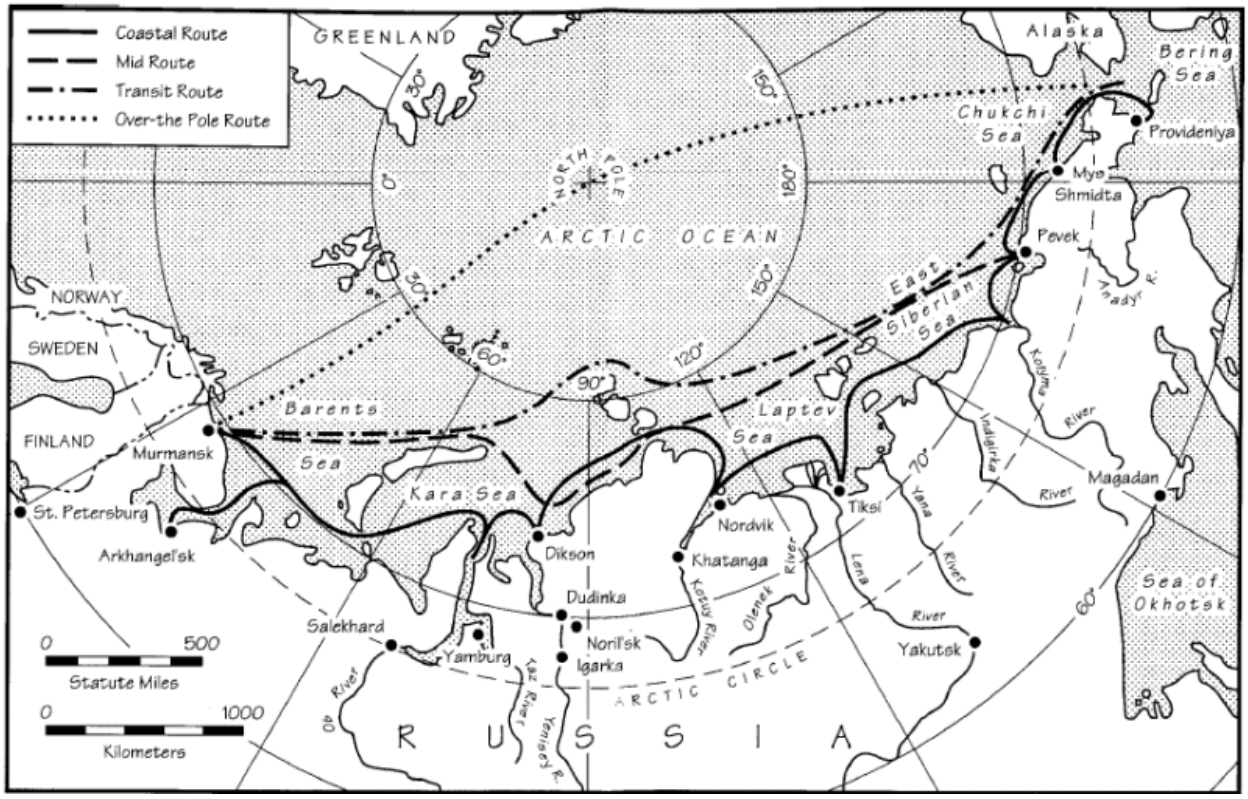

Figure 4.1: Map of Northern Sea Route and various NSR options (Source: http://www.globalsecurity.org)

4.4.1. Murmansk port

Port of Murmansk is one of the greatest ice-free ports in Russia. The necessity of such port construction was realized during the World War I, when Saint-Petersburg port and all the

Black Sea ports were blocked by enemies, and Archangel port froze. Then the only way was the urgent building of the new port on the North of Russia.

At the end of June - beginning of July 1915, the first scheduled works were conducted on the territory of the future port, and on September, 1st of 1915, the first steamer Drott with a cargo from New York moored to a temporary dock. Thus, September 1 can be regarded as the birthday of the port of Murmansk (Murmansk Commercial Port, 2010).

The warm Gulf Stream makes the climate soft in this part of the Kola Peninsula. The Gulf does not freeze, even in severe winters, which allows year-round navigation without ice posting. The width of the Kola Bay and the depth of the channel let almost any craft without restrictions on length or sediment to come in and get in the anchorage.

The Murmansk port consists of three ports: commercial port, fish port and passenger port. Currently, the most developed port is Murmansk Commercial Port. It gets its rapid progress due to the increasing export of carbon and other mineral resources.

The main features of Murmansk Commercial Port are (Murmansk Commercial Port, 2010):

1. Location is 68 degrees 58 minutes N; 33 degrees 05 minutes of E.
2. The navigation in the Port is open 24 hours and all year round.
3. The tide changes occur approximately every 6 hours. The difference of the water level is 3,66 m.
4. The gulf is ice-free but in severe winters it is iced for a short time; but normally the ice is drifting.
5. The depths on the roads are 20-60 m.
6. The speed of the tide can be 2,5 knots.
7. Density of water in the bay is changeable within the limits 1,000-1,025 ‰ subject to tides.
8. Murmansk Commercial Seaport is the only port in the northwest of Russia handling the vessels with the deadweight up to 130 000 t.

9. On the territory of Murmansk commercial seaport operate two stevedoring companies: Open Joint Stock Company «Murmansk Commercial Seaport» and Closed Joint Stock Company «Agrosphere».

10. OJSC “Murmansk Commercial Seaport” is divided into 3 districts. Handling and storage of the general cargoes, bulk cargoes and cargoes in containers are possible on the 1st and the 2nd cargo districts. The storage and loading of vessels with apatite concentrate in bulk by conveyor is provided by the 3rd cargo district.

11. JSC “Agrosphere” is the specialized complex for storage and loading of vessels with mineral fertilizers in bulk by conveyor.

12. OJSC “Murmansk Commercial Seaport” and JSC “Agrosphere” are Terminals.

According to the program of development of Murmansk port, it is planned to provide implementation of complex investment projects in the value of 157 billion rubles (it is about $ 6 billion), of which 60.9 billion rubles will be allocated from the federal budget for railway projects, funds RZD and Investment Fund; the remaining projects, such as construction of oil terminals capacity of 35 million tonnes (46 billion rubles), construction of Coal Terminal (14.4 billion rubles) and a container terminal (10.9 billion rubles), must be financed by private investors (Murmansk port will be ready for the load, 2007).

According to A. Davudenko (Federal Agency of Marine and River Transport CEO), in accordance with the Federal target program “Development of the Russian transport system for the period 2010-2015”, it is planned to build a new port and railway infrastructure in the port of Murmansk and the western part of the Kola Bay (A. Davudenko: Port of Murmansk - the gateway to the offshore treasures of Russia, 2009). In particular, the project development of the Murmansk transport hub provides for:

1. the establishment of marine container terminal (cargo handling up to 1 million TEU per year),

2. the construction of coal transshipment complex on the West coast of the Kola Bay near the Lavna river (capacity of 18 million tons per year),

3. the development of a coal terminal on the eastern shore of the Kola Bay (capacity up to 12 million tons per year),

4. the building of oil terminal on the West coast of the Kola Gulf (35 million tons a year),

5. the construction of a new railway branch (27 km) along the western shore of the bay,

6. the building of dedicated logistics center.

Development of the Murmansk transport hub and the planned increase in turnover of existing terminals of the Murmansk port requires the opening of additional crossing points across the sea border. Russian government considers that it is appropriate to open a checkpoint in the village Liinakhamari (Murmansk region) (A. Davudenko: Port of Murmansk - the gateway to the offshore treasures of Russia, 2009).

Implementation of port project of the Murmansk transport hub is only available on public-private partnership. Davudenko said: "*We need to make the project attractive to inward investment. Therefore, I believe we must go back to the establishment of a special economic zone in the port of Murmansk. This will enhance business and investment activities in the port, create preconditions for attracting leading innovative technologies to the region and give impetus to the development of Arctic transportation*" (A. Davudenko: Port of Murmansk - the gateway to the offshore treasures of Russia, 2009).

The implementation of these improvements is planned to start due the period of 2010-2015.

4.4.2. Vladivostok port

Vladivostok is the biggest Pacific port of Russia, located on the northwest coast of the Sea of Japan. It takes the entire area of the Bosporus-Eastern and bays, jutting out into its banks (the Golden Horn, Diomede, Ulysses, Novik), as well as part of water area of Amur Bay. The advantages of the Vladivostok port to the other ports of the Far East are the existence of closed raid and deep bays, suitable for mooring of vessels with large rainfall (Ports of Russia: Vladivostok, 2010).

The main features of Vladivostok port are (Ports of Russia: Vladivostok, 2010):

1. Navigation in the port is year-round.

2. In the winter (late December to early April), the Bosporus-Eastern Strait, as well as all of the bays, jutting out into its banks, except the Golden Horn Bay, is covered with ice. Freezing of the eastern part of the strait is prevented by continuing all winter shipping, so vessels can navigate in the bay without ice-breakers assistance.

3. In Vladivostok, there are Vladivostok Commercial ports and the fishing port, shipyard and mechanical plant and other enterprises of the city.

4. Depth of the approach to the inner roads allows movement of ships with a draft up to 19 m.

5. Vladivostok Commercial Port takes to process vessels a draft up to 11,0 m, a length up to 260 m and a width of 40 m.

6. It consists of 16 deep water berths with depths ranging from 7.3 m to 11.6 m. Twelve of these are cargo berths. Nine of cargo berths are designed for handling general cargo, one- for handling grain, one is specialized for loading and unloading containers of various sizes, and one is for the processing of perishable goods.

7. In addition, the Commercial port includes several shallow berths used for the repair of harbor craft and the transport of passengers in local traffic.

8. The total length of berthing front sea port is about 4,0 km.

9. All freight and deep-water berths are connected with the railroad, whose total length is about 28 km.

10. Vladivostok port is divided into two cargo area, passenger terminal and storage depot.

11. The first cargo area specializes in the handling of metals, timber, reefer, various packaged cargoes.

12. The second cargo area specializes in transshipment of metals, grains, raw sugar, petroleum coke, various packaged cargoes. One of the berth operates a container terminal with a capacity of 100,000 20-foot containers a year.

In 1991 Commercial Port of Vladivostok was opened to foreign shipping activity, since then export-import turnover has steadily been enhancing (Commercial Port of Vladivostok, 2010).

4.5. Atomflot: the ice-breaker fleet of Russian Federation

In connection with the exploration and development of the Russian Far North areas, it has become an urgent task to create a powerful nuclear icebreaker fleet in the early 50s of XX century. It was necessary to provide year-round transportation of goods along the Northern Sea Route. Huge amounts of various goods for mining and resettlement of residential areas was brought to the Western and Eastern Siberia, and mining products, timber, oil, gas and other resources went on the other way from Siberia.

Nuclear-powered icebreakers have undeniable advantages for Arctic ice steering. Autonomy of operation comes up to 6-8 months. Icebreaker "Arktika" worked without calling at any port for exactly 1 year (from May 4, 1999 to May 4, 2000), resource nuclear fuel provides the nuclear-powered icebreakers operation for 4-5 years (Nuclear Icebreaker Fleet, 2009).

The nuclear icebreaking fleet was developing nearly in parallel with domestic nuclear power. The decision to build the first nuclear icebreaker was taken on November 20, 1953, and the ship's keel-laying took place at Admiralteyskiy Zavod (shipyard) in Leningrad on August 24, 1956 (to compare, the world's first NPP in Obninsk (near Moscow) was started up on June 27, 1954). The nuclear icebreaker Lenin was launched on December 05, 1959. The 510 manufacturing plants and organizations all over the country were involved in its building (Nuclear Icebreaker Fleet, 2009). Now, Lenin is out of service and it operates as the museum.

In 2007, the construction of the icebreaker 50 Let Pobedy (75 000 horse power) was completed at Baltiiskiy Zavod in St.Petersburg after a 15-year pause. This nuclear icebreaker, which was put in operation in March of 2007, is currently the largest in the world (State Atomic Energy Corporation "Rosatom", 2008).

Russia has the most powerful icebreaker fleet in the world, as well as unique experience in the design, construction and operation of such ships. The fleet includes six nuclear icebreakers, one container ship and four maintenance ships. The icebreakers' mission is to keep the Northern Sea Route available all the time and provide access to the Far North regions and Arctic shelf.

Atomflot operates currently four icebreakers with the capacity 75 000 horse power (Rossija, Sovetskiy Soyuz, Yamal and 50 Let Pobedy), two icebreakers with 50 000 horse power (Taimyr and Vaygach), and a lighter container ship Sevmorput with 40 000 horse power (Nuclear Icebreaker Fleet, 2009).

It is planned to develop in 2009 a design of a new-generation two-draft icebreaker that will be capable of running both in deep rivers and on sea. ROSATOM is planning to start series production of such icebreakers; they will make the core of Russian nuclear fleet in future (State Atomic Energy Corporation “Rosatom”, 2008).

Mr. Rautio said: “*Today Russian nuclear icebreakers operated by Atomflot is keeping the route open during periods of difficult ice conditions, and they will still operate on commercial basis in the future. In addition, operators regulary using the route – as Norilsk Nickel – have found it financially profitable to build their own combined cargotransporters and icebreakers by a special Finish vessel design*”.

According to info-portal Energyland (2009), Central Design Department "Iceberg" is preparing a draft of a universal nuclear-powered icebreaker with the capacity of 60 megawatts, so that in 2010 to begin its construction. According to the head of Rosatom, Sergei Kiriyenko, it will take about seven operating icebreakers to develop the Arctic shelf of Russia. Furthermore, in 2015, as predicted by the Ministry of Transport, freight flow of nuclear icebreaker fleet will grow by more than eight times - up to 16 million tons (Russian nuclear icebreaking fleet is celebrating 50 years anniversary, 2009).

The new icebreaker will be multifunctional. The vessel will be able to perform icebreaking assistance, to ensure rescue operations, to be used in oil spill response. Features of the new icebreaker allow the steering convoys throughout the Northern Sea Route in the traditional terms of Arctic navigation from late May-early June till October and year-round in the western Arctic region (Fleet of Russia will be strengthened by the new nuclear-powered icebreaker, 2010).

Mr. Solberg expressed his negative opinion about the ice-breaker assistance and its effect on the economical feasibility of the NSR: “*Whatever Russians will do, it will be expensive: you need icebreaker support or double-acting ships, etc, so it will not be economically competitive in comparison with Suez Canal*”.

4.6. Climate and ice condition in Arctic

The weather and ice conditions are very important, when navigating in Arctic. Bad weather may cause the risk of being out of schedule, and difficult ice conditions may cause vessel damage and other bad consequences. The length of the navigation season, the speed of sail and the need for ice-breaker assistance is also dependent on the ice condition.

The researches, provided during the last ten years, are permanently showing that the Arctic ice has been shrinking and thinning over the last few decades. However, there is a kind of uncertainty about the character and the speed of melting that is why the predictions are quite different. But only the time length differs, when the scientists suppose the Arctic Ocean will be completely ice free during summer time (Ragner, 2008). The Arctic Climate Impact Assessment (ACIA) indicates the NSR sailing season for ordinary cargo vessels will be prolonged from the current 25-30 days to around 120 days. New generations of larger, ice-strengthened cargo vessels might be able to operate unescorted for longer than that (Ragner, 2008). As to today's situation, some areas of the NSR is covered with hard multi-years ice, which can not be overtaken by usual cargo vessel, thus the ice-breaker assistance or the use of specialized high ice-class vessels is needed.

The physical environment of the northern coast of Eurasia - the Russian maritime Arctic - presents unique challenges to the mariner and to modern ship technology and systems. One defining threshold of the Arctic environment that is often used is set by the 10°C July isotherm. This isotherm marks the southern Arctic boundary where the monthly mean temperature in July is below 10°C. The temperature in January within the Arctic Circle is all below 0°C (Arctic Council, 2009). The frost may vary from about -5°C to greater than -35°C.

Precipitation, generally, is light within the Arctic at less than 250 millimeters per annum. Only along exposed coastal regions in southern Baffin Island, western Greenland and northern Scandinavia are amounts greater than this regularly experienced.

The seasonality of the polar environment, in this case the overall annual weather patterns over the Arctic Ocean, is a critical, strategic aspect for planning current and future marine transport systems throughout the Arctic (Arctic Council, 2009).

The scientists and scientific institutes are permanently monitoring the climate of Arctic and the ice condition. The snapshot, presented below, shows the minimum coverage of Arctic sea ice in the satellite era of observations. Striking are several notable features: the largely ice-

free areas across the Russian Arctic coastal seas (north of the Eurasian coast), except for a small region in the western Laptev Sea; an ice edge that has retreated north of Svalbard and well north in the Beaufort and Chukchi seas; several ice-free passages through the Canadian Archipelago; and a large area of the central Arctic Ocean that previously has not been observed open or without even a thin ice cover (Arctic Council, 2009).

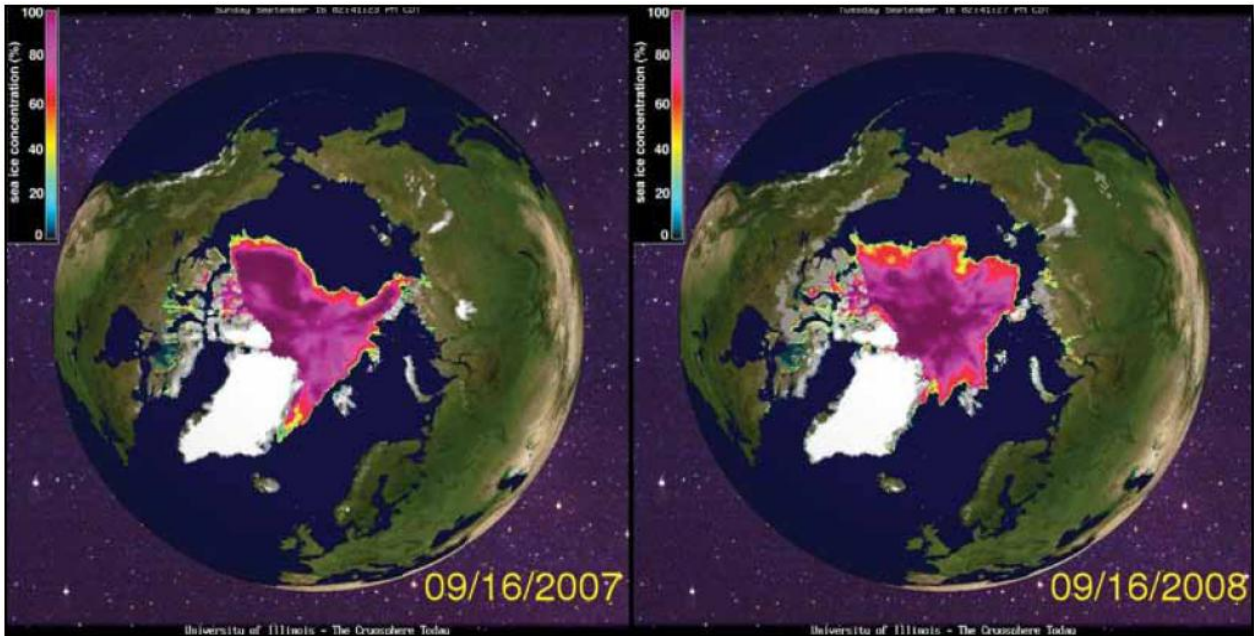

Figure 4.2: Satellite images of summer sea ice cover (Arctic Council, 2009)

However, that is highly important to notice, that despite the remarkable, ongoing changes in Arctic sea ice and some uncertainty surrounding the output of the Global Climate Models, no research have indicated that the winter sea ice cover of the Arctic Ocean will certainly disappear during this century, but such a possibility exists.

4.7. The Main Interested Parties in Wide Opening of NSR

4.7.1. Russian Federation Government

The Northern Sea Route is defined in Russian law as the set of Arctic marine routes between Kara Gate in the west and the Bering Strait. Subdivision of RF Government the Marine College is responsible for the implementation of national marine policy in the Arctic, according to "Marine doctrine of Russia for the period until 2020". In addition of the main course, the doctrine considers integration of NSR to the international transport system, Transport Ministry of Russia has conducted activities to consolidate the status of the Northern Sea Route as an independent Eurasian maritime transport corridor under Russia's control (Marine College, 2009).

In 2009, government enacted to conduct the modernization of the economy by implementation of the united national transport-logistic system. The main part of such modernization is played by transport corridors and NSR precisely. The development of NSR is important for Russian government from different sides: geopolitics, economics, ecology, science and defense. The full-fledged NSR will help to evolve the arctic regions and draw it to industrial turnover.

To achieve these objectives, the Presidium of State Council and the Marine College of the Russian Federation scheduled concrete measures during a joint session held in May 2007 (Peresypkin, Yakovlev, 2008).

4.7.2. Noncommercial Partnership for the Coordination of Northern Sea Route Usages

Noncommercial Partnership of the Coordination of Northern Sea Route Usages was registered on June 28th 2001 to improve management structure and to increase effectiveness of Northern Sea Route usage. Partnership is a noncommercial organization. Partnership's aims are to coordinate activities of Partnership members in the sphere of effective usage of Northern Sea Route, to assist in trade navigation and in solving property, economic, technical, legal and Arctic environment protection problems.

The Partnership is comprised of Russian shipping companies, Russian Federation government officials and international institutes (Annual report of Institute of the North, 2007). Members and sponsors of Partnership are the following companies of Russian Federation: United Industrial Corporation, Ltd., ITNAARI, LUKOIL-Kaliningradmorneft, Arctic Shipping Company, Arctic Trade and Transport Company, Gazflot, Far Eastern Shipping Company,

Lenmorniiproekt, Kurchatov Institute, Lena United River Shipping Company, Morinteh, Primorsk Sea Shipping, Scan Ex, as well as 300 representatives of companies and public authorities of the northern regions of the RF and 7 countries (The Meeting of Council of Noncommercial Partnership of the Coordination of Northern Sea Route Usages, 2009).

The main purpose of the Partnership for the nearest few years is the promotion of draft law, called as "Northern Sea Route". The law proposes the centralized governance of the transport system, icebreaking services, and providing a clear access to regulated terms of carriers, including foreign ones.

4.7.3. Norwegian Barents Secretariat

The Norwegian Barents Secretariat was established after the signing of the Kirkenes Declaration on January 11th 1993, where Norway, Sweden, Finland and Russia set up the Euro-Arctic Barents Region (Promoting Norwegian- Russian relations in the North, 2009). The main purpose of Norwegian Barents Secretariat is the development of the Norwegian-Russian relationships in the north by promoting and funding Norwegian-Russian cooperation projects.

The main interest of Norwegian Barents Secretariat is in the industrial development of the Northern oil and gas sector and implementation of major projects in this sphere. It was established on the Murmansk Economic Forum 2009, that oil shipping in the western part of the Russian Arctic has over the last years shown a steady increase. In the light of these facts representatives from the Norwegian Barents Secretariat met with the head director of Noncommercial Partnership of the Coordination of Northern Sea Route Usages A. Chilingarov. He said that Russia is prepared to develop international cooperation on exploration of the Northern Sea Route and a representation office can be located in Kirkenes (Filin, 2009). And the secretariat is currently working for the establishment of this representation office.

4.7.4. Cargo Carriers

Instead of perspectives for oil and gas carriers, NSR also give the opportunities for other resources exporting. For example, the development of export metal, mineral and chemical products from the Krasnoyarsk region via the Yenisei River and the NSR. Exports are projected to reach 2 million tonnes per year, utilizing both ocean-going vessels and river/sea vessels (Ivanov, Logvinovich, 2008).

Russia's northern communities are dependent upon maritime shipping via the Northern Sea Route and navigable rivers for deliveries of foodstuffs, liquid and solid fuels and other essential goods and materials. These imports are delivered by ocean-going, river/sea and river vessels and already amount to about 15 million tonnes per year (Ivanov, Logvinovich, 2008).

Northern Sea Route can allow to organize transportation of fertilizers from the Kola Peninsula in East Asia to China.

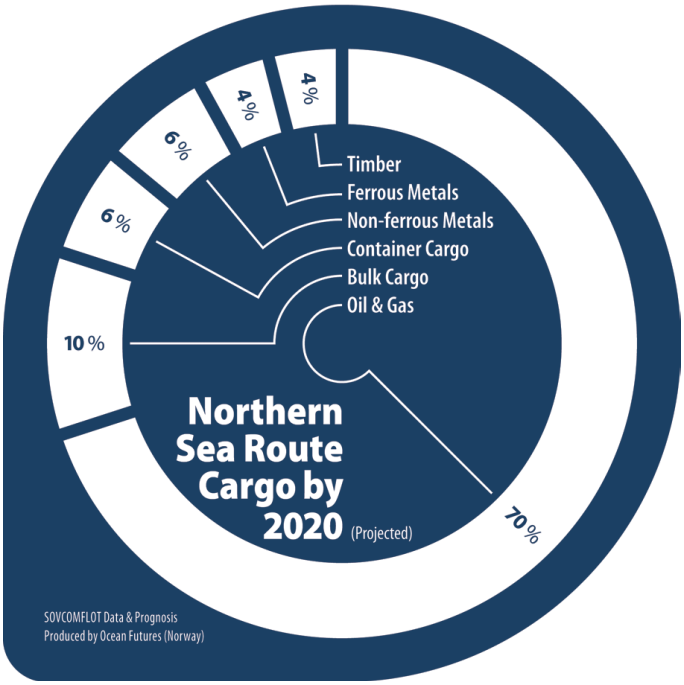

Figure 4.3: SOVCOMFLOT Data and Prognosis (produced by Ocean Futures, Norway, 2009)

4.8. Experience of the industrial companies in use of the Northern Sea Route for transportation of export goods

4.8.1. Russian side

It is appropriate to consider the experience of Norilsk Nikel (NN). The company develops deposits of ore minerals and produces a commodity output. In contrast to many other companies, NN has the only two opportunities of exporting its goods. They are both by water-ways: NSR and the Jenissey river. Sea transportations are carried out all-the-year-round, since 1979, with the use of vessels of an high ice class under icebreaker assistance - the break in such transportations in May - June arises owing to a floating of ice and flood on the river Jenissey. This way has privilege against the river way, because Jenissey is opened for navigation only for summertime. The volume of cargo handling is about 1,2 million ton / year, including about 1 million tons of Company's cargoes.

As well as the last years, Open Joint Stock Company Murmansk Shipping Company renders transport services on carriage of cargoes of the Company by NSR using vessels (own) of the an icestrengthed ice class. The nuclear linear (such as "Arctica") and shallow-draft (such as "Taymyr") icebreakers, which are the state property and in trust management of the Murmansk Shipping Company are used for realization of icebreaker assistance for transport vessels with cargoes of NN by Northern Sea Route.

NN experiences the following inconveniences, such as:

- pays up to 80 % of charges of icebreaking fleet
- deficiency of icebreaking forces, because of other consumers of NSR, such as Lukoil and Gazprom
- deterioration of transport fleet of the Murmansk Shipping Company

After the analysis of that situation, the decision to build its own reinforced ice-class fleet was made in 2004. It was completed in 2009 by constructing the 5^{th} and the last vessel called "Hope". Arctic fleet of NN was included in the RF Register of Customs Carriers. This status allows not applying the enforcement of the customs legislation of Russia, such as: ensuring payment of customs duties in respect of goods for customs, customs support and routing of traffic; in respect to NN. Inclusion to the Register of Customs Carriers, along with the use of electronic declaring, allows NN to streamline the processes of customs administration of cargo significantly (Norilsk Nickel has completed the formation of its own Arctic fleet, 2009).

4.8.2. Foreign side

NSR can not boast of sufficient experience in the field of cooperation with other countries. The brightest example of such experience is the recent passage of Beluga Shipping 2 vessels from East to West. This was the first time since World War II that foreign vessels travel this Arctic route

Niels Stolberg, President & CEO Beluga Shipping GmbH , mentioned in the interview:

"As from 31st of August 2009, from position 70° 19' North 170° 09' East forward, MV „Beluga Fraternity" and MV „Beluga Foresight" sailed in a three-ships-convoy following Russian Atomflot-ice breaker "50 Let Pobedy"; at the entrance to the Vilkizki Strait on the 4th of September, the northernmost part of the Northern Sea Route transit, the convoy was enlarged by icebreaker "Rossia" as from position 78° 06' North 105° 47' East on. Since the end of August, the vessels encountered some small ice bergs, ice floes and remaining ice fields with mostly little concentration which due to the ice breaker assistance and their ice-hardening could be safely navigated through. When the convoy entered the Kara Sea the ice breakers departed. The Ob-delta including the port of discharging Novyy Port / Yamburg was completely free of ice".

Two multipurpose heavy lift project carriers, the MV "Beluga Fraternity" and the MV "Beluga Foresight", reached their destination in Siberia on 7th of September 2009, within a few hours of each other the vessels which are loaded with heavy plant modules each dropped their anchors at Novyy Port / Yamburg in the delta of the river Ob,-reported the official web-site of Beluga Shipping (by materials of official site of Beluga Shipping, 2009).

The features experienced by Beluga were:

1. the rejections in permission for pass through NSR and sequent delays of the project;
2. the long-term process of acquiring of the permission to pass the NSR from the Russian side, Mr. Stolberg said: "*We had several months of internal preparation and applied for permission to transit the Northern Sea Route in April 2009. On the 21st of August 2009 the official permission was granted. By then both vessels had already successfully passed the clearance by the authorities in Vladivostok so that we could cast off after the "green light" was given*".
3. complicated scheme of permission acquisition, because of the necessary approval by the Russian Ministry of Agriculture, the Russian Ministry of Defense, the

Russian Secret Service and the Russian Government, provided by several hundred of documents

4. necessary assistance of in-company meteorologists. Niels Stolberg mentioned also that : *"Our two in-house meteorologists are specialists in analysing the satellite and weather data and in close teamwork with the experienced Masters, our Chartering and Operations department and our experts in the department Health, Safety, Security & Environment, they created detailed routing suggestions minimising risk or danger during the Northern Sea Route transit which were frequently sent on board plus weekly ice reports about the current and coming situation more generally. We received the satellite pictures and data material from the University of Bremen, Germany, home town of Beluga Shipping as well. Also our meteorologists were in loose contact with the "Arctic and Antarctic Research Institute" (AARI) in St. Petersburg in order to secure the possibly of getting more background material on the ice situation if had been necessary".*
5. the convoy was enlarged by two icebreakers, cause since the August the vessels are encountered some small icebergs, ice floats and remaining ice fields with mostly little concentration, which due to the assistance of icebreakers could be navigated safely.
6. the ice breaker hire is a regular service component included in the "Charters Agreement", it has been arranged that customer of Beluga cover the costs for ice breaker assistance and for any delays possible caused by the weather, so this item of expenses was not included in the costs of the company
7. insurance types were Hull & Machinery and Protection & Indemnity, they were allowed by the insurers, names of which Beluga kept in secret. *"We used the same insurers who we trust in and who trust in us for several years"*-said Mr. Stolberg.

Mr. Eger noticed that the possibility of acquiring the insurance become real because of the excellent qualification of Beluga before insurance company. He said: "*Beluga's process was a very good planed, and this helped them to get and reduced the insurance premium when they were negotiating about it. According to Beluga, the insurance premium was not very significant, although they didn't the name of the insurance company*".

Although, the information about the value of insurance premium is confidential, but Mr. Stolberg mentioned in the interview: "*What we can let you know is that special meetings had been held between our experts and*

representatives of the insurers. The details of our planning and preparation processes, the routing proposal, technical details of the vessels and not least solutions for the "possible problem of ice impact" et cetera had been presented to the underwriters who then decided on the extra premium applicable for this particular project".

The advantages for Beluga Shipping got from this passage were concerning about time and fuel savings. The overall net savings for each ship can be confirmed as $300000, the rough calculation of this sum is the reducing the bunker consumption of low sulphur fuel by about 200 tons in total per vessel, which allows to save about $100000 for each bunker, and also additional $20000 saved daily-costs for each day travelling shortens the usual time (about ten day in comparison the passage through Suez Canal). The hire of ice breakers was not included in the balance sheet because of its relation to the customer (by materials of official site of Beluga Shipping, 2009).

The fee for passing the NSR amounted, according Niels Stolberg, to "*only a comparably moderate five digit figure in US-Dollars which is less than the fees for a Suez Canal transit on the alternative and traditional route connecting Asia and Europe*".

For 2010 Beluga Shipping plans to transit the Northeast-Passage again. Contracts for the shipment of various heavy lift pieces with single weights of up to 1,000 tons are already booked in today and will have to be discharged offshore onto barges in Siberia to be further transported into their respective areas of destination. The Northeast-Passage 2010 is planned with up to six vessels. Their maximum tonnage capacities of 20,000 tons deadweight and crane capacities of 800 to 1,400 tons provide for a new generation of Beluga multipurpose heavy lift project carriers. In this time Beluga is planning to save approximately about $600000 per vessel (by materials of official site of Beluga Shipping, 2009).

According to the opinion of Mr. Rautio, the NSR can be interested for other shippers, mainly to oil and gas transporters. He said: "*All international cargo transporters operating in the market for oil and gas development will have interest related to the development of the petroleum fields in Arctic Russia. This includes transporters of petroleum products. In addition, cargo transporters operating on the line Asia – Europe should benefit from using this route*".

For the question about the demand for the NSR amongst non-resources cargo shippers, Mr. Rautio said: "*It will be a question of price for operating on NSR with nuclear icebreaker*

assistance, as well as other costs (in case of open water and no icebreaker support). In the future I believe that the formal procedures will be easier and more like routine".

4.9. NSR as the possible competitor of Suez Canal

Nowadays the transportation route through the Suez Canal, known as Royal Route, is much in demand, and it is the most popular way for transportation goods between Western Europe and Eastern countries. The trade flow is increasing from year to year, due to development of market relationships between East and West. More and more goods now are imported to Europe from Japan, China, and other Eastern countries. The huge part of them is transported through the Royal Route. According to the statistics, provided by Suez Canal Authority, the ship flow though the Canal is increasing every year, as well as the amount of goods, transferred. The number of TEU, transferred through the Canal, during 2006 was 28 552 608, in 2007 – 34 140 663 and 35 440 747 in 2008 (Suez Canal Authority, 2009).

The number of ships and the flow of cargo are increasing permanently, and the Canal is operating twenty four hours a day. Also Egyptian government decided to reduce the fee for passing the Canal, because few global companies like Maersk and CMA CGM decided to use the route along Africa and Cape of Good Hope, trying to save ships and cargo from pirates and high rates for passing the Suez Canal. This measure and the rise of the fuel cost had their effect, and, according to InterMost Logistics (2009), Maersk and CMA CGM/CSCL have returned two of their routes (few ships of 9500-10000 TEU and 9 ships of 9500 TEU correspondingly) to the Suez Canal. That change helped them to shorten the trip time from 9 till 8 weeks. Only EU-3 route guided by Grand Alliance is still voyaging from Europe to Asia using the longer route, but specialists maintain that if there is no change in fuel price in nearest future, Grand Alliance will also send the cargo through Suez Canal.

Some analytics assumed that the growth of import and the increased inflow of ships, brought by unavailability of Panama Canal to satisfy the grown demand, and reduction of Suez Canal toll rates may cause the overcapacity of Suez Canal. The research “Is the North Sea Route a worthy alternative to Suez Canal in container shipping?” (2009) showed that the planned deepening of the Canal will lead to appearance the additional capacity, thus the overcapacity will be avoided.

All of the largest logistics companies, like Maersk Line, CMA CGM, Mediterranean Shipping Company S.A. and others are now using Suez Canal for container shipping, but these companies have ships, that exceed the Suezmax limit. Such supertankers and huge container ships, in order to avoid a round-trip via Cape of Good Hope, have to discharge a part of their cargo, to the terminals, or "tranship" to smaller vessels, which enlightens the chances of the

Supertankers to pass through the Suez Canal (Balu, 2009). After crossing the Canal, these ships again load the cargo and then start their sea voyage.

The planned increase of possible ship draft will allow logistics companies to use their largest container ships at full load, while passing the Suez Canal.

In sight of the facts, mentioned above, the NSR can not be called the direct competitor of Suez Canal for now, but it is considered as the high-potential addition to Suez Canal, as R. Rautio, the Regional Director of Rambol Company, said: "*I believe that Suez and NSR will be necessary together – and they will serve separate to some extent (based on the origin of the goods to be transported and the port of discharge) markets*".

Mr. Solberg on the contrary believes: "*It is like a market. Now Suez Canal has a monopoly, but to the moment when they don't have a monopoly anymore, the whole economic picture changes. If the NSR will be able to become cheaper than Suez Canal, Suez Canal will be even more cheaper, and it will not be economically feasible for the NSR*".

It is hard to predict, but there is a stable opinion, that due to the global warming the amount of Arctic ice-coverage will reduce and this will allow navigating the NSR from six up to nine months per year (Liu, Kronbak, 2009). This opportunity will make the NSR more competitive and profitable to use in comparison with Suez Canal navigation.

4.10. Summary

This chapter provides the research with the necessary empirical data to help to uncover the problem statement of the research. It has been described the results gained from 5 interviews and secondary data resources. The historical background of the NSR, as well the current condition and perspectives for the future were expounded in this section.

5. Analysis and Discussion

In this chapter the authors analyze the interviews and collected empirical data presented in the empirical chapter of the research in order to answer for the main question of the research: Will it be economically feasible for shippers to use the NSR for the transit shipping?

During the analysis stage it is planned to discuss the current condition of the NSR and future perspectives concerning the development of the route, uncover the weaknesses and the possible solutions of that problems.

Based on the described pitfalls the case study is composed. The case simulates the situation when the NSR route is in use for transit routing and calculates the economic feasibility of using it for a certain freight company. The results of this case will be compared with the similar research concerning the Suez Canal use. After that the list of conclusions will be made.

5.1. Weaknesses of the NSR and possible adjustments

During the research a lot of empirical data, connected with all aspects of the NSR existence and functioning, was gathered. Historically the NSR was used for national transportation primarily. Since the idea of using the Route in Arctic was born 150 years ago, Russia was using it for transferring agricultural and mineral goods from Siberia to world markets. But extreme weather conditions were the main trouble all the time. The level of technical development and science, and high costs of building vessels, which will be able to deal with Arctic ice, did not afford to establish permanent transition of goods along the Route. Due to the fact, that the main country, which was developing the NSR, was Russia, the socio-economic crisis in 1990 made bad effect for condition of the NSR infrastructure. That was a big step back in development of the Route.

Nowadays there are many parties, interested in development of the NSR. They include Noncommercial Partnership of the Coordination of Northern Sea Route Usages, Norwegian Barents Secretariat and Russian and International cargo carriers, as well as Russian Government. All of them are now developing plans of using the NSR, and some of them have already started the implementation. For example, Russian Government had invested in assembling new atomic

ice-breakers during the program of renewing the Arctic fleet. The newest ice-breaker “50 let Pobedy” was set in operation in 2007. The reconstruction of northern ports is also planned as a part of the development of the NSR.

5.1.1. Weather conditions dependence

Despite of these facts the present condition of the NSR is not appropriate for regular transportation along the whole length of the Route. The scientists are predicting that, due to the global warming, the number of ice-fields will reduce enough, allowing sailing through the NSR up to nine months per year or even more, but now the Route in navigable only four months per annum. Of course, the part of the NSR from Murmansk to Dudinka is navigable all year long thanks to atomic fleet, but that is not so important for international container shipping and can be interesting mostly for companies of oil and gas industry.

5.1.2. The lack of high ice class vessels

In a row to weather conditions there is another weak point of today’s NSR condition – the lack of high ice class vessels, which can be used during the most part of the year in High North. But the solution of this problem depends on investors and can be solved in shorter term, than a previous one. That can be assumed that as soon as the NSR will become more attractive for international shipping companies from economical point of view, it will not take long time the Arctic container ship fleet to be created.

There are already credit programs in some banks, developed for companies, which are going to buy an ice-class vessel (Verny, Grigentin, 2009). That is very useful because of the high market price of such vessels (they can be twice cheaper than the ordinary containerships of similar capacity).

The technical requirements for vessels, operating in Arctic, are very strict and need the implementation of modern technological solutions. The ships of ice-class should be very maneuverable and have the same propulsion power astern as well as forth. It will help ships not to get stuck in ice. The main common way of meeting the requirements is the use of electromotor for propulsion.

The hull of ice class ships should meet very strict requirements too. Due to the fact, that Arctic nature is very vulnerable, the double hull should be used to decrease the risk of pollution of the area by fuel oil and other oil-chemicals. The second reason for such a requirement is the long time, which is needed to reach the vessel in case of emergency. Double bottom, time of

reverse less than 45 seconds, stainless steel or high-strength bronze propeller with not less than four blades, watertight closing shaft tunnel, 30 days garbage container, ballast side tanks with heating system, and other systems and technologies are needed for safety reasons.

5.1.3. The limitation of high ice class vessels usage

The usage of modern technology and additional materials influences badly the price of the vessel, but, unfortunately, there is no other way to reach the needed level of safety during the sail. From the other hand, the high price of the ship can be compensated by the shorter travel time, but can it?

Unfortunately, the sail speed of an ice class vessel is lower, than the speed of ordinary container ship and, in addition, the waiting time is huge in comparison to the Royal Route. According to the real practice (taking the passage of Beluga Shipping Group vessel as an example) it takes approximately half a year to get all the permissions for passage from Russian government. The bureaucracy is enormous, the documents, mentioned in Rules for Navigation on the Seaways of the Northern Sea Route, are enough, but they should be signed Russian Government, the Ministry of Defense, the Ministry of Agriculture and the Russian Secret Service plus the regular by port and custom authorities in Vladivostok or Murmansk, depending on the departure point.

5.1.4. High insurance premium

Another necessary point to mention is insurance. The insurance premium nowadays for such an extreme journey as the trip through the NSR is quite high. The exact amount is varying, depending in the cargo value, the condition and equipment of the vessel and the availability of ice-breaker convoy, but anyway the premium can appear times higher, than the analogous premium for Suez Canal transportation. Another problem is the fact, that very rare insurance company nowadays will give insurance for a whole NSR journey. As practice of Beluga Group shows, the passage should be planned in a very detailed way and quite many scientific meteorological institutes should confirm the safety of passage for insurer.

5.1.5. Imperfection of legal framework

As it was found out, there are two main legal frameworks that should be followed while navigation in Arctic. They are IMO Guidelines and Russian Rules for Navigation on the Seaways of the Northern Sea Route. These documents both contain the list of requirements for ship crew and vessel technical rigging. Russian Rules also includes the list of documents, needed

for passage through the NSR and the responsibilities of ship-owner and Russian government. There are two main problems here:

- First of all, many experts claim, that these document are not well prepared and do not contain all the information, needed for providing the safe passage.
- While the IMO is making changes to its guidelines, listening to the experts, Russian Rules were not changed since 1996. Thus the Russian side is not paying attention to the guidelines, approved internationally, and does not follow IMO recommendations.

Probably, the main reason for such attitude to IMO Guidelines is caused by its not obligatory force, when Russian Rules and Requirements are compulsory. The Maritime Safety Committee is now reviewing the possibility of making IMO Guidelines mandatory, but that is just a project for now. It seems that creation of the unique guide for ship owners, who decided to navigate through the NSR, will help both seamen and controlling organizations.

5.1.6. Ports and terminals

At least, the conditions of ports and terminals should be mentioned. According to the latest data, only a half of 41 northern Russian ports, situated along the NSR, are now functioning. This situation can badly influence the safety, because the distance to the nearest port in case of emergency increases. But the key ports of the NSR – port of Murmansk and port of Vladivistok – are now fully functioning. Port of Vladivistok has its own container terminal, and the port of Murmansk will have such a terminal in close future after the total reconstruction. However, it is important to notice that in case of transit transportation through the NSR these ports will be used for customs service and for fuel filling in the first place.

Here is a case study, which was composed, taking into account the disadvantages of current NSR situation, and taking into consideration the steps of development and their influence in the nearest future.

5.2. Case study

The main target of performing this case study is to investigate possible economical feasibility of using double acting ships at NSR for permanent liner route between Rotterdam and Yokohama. This is a try to compare the costs of transportation of one TEU through the route, using DAS, using ordinary container ship with ice-breaker support and transferring one TEU through the Royal Route.

The Double Acting Ships are picked up for the case study, because of their innovative concept and better navigation characteristics. Due to their ability to move stern in ice fields, they do not need ice-breaker support. The ABB Azipod propulsion system makes these ships very maneuverable. This characteristic helps them to move in ports and avoid extra assistance from tugboats. Also their engines are more effective in comparison to ordinary ships of the same class, so they consume less fuel oil, while providing the same power.

The main problem is that NSR is not navigable during whole year nowadays, but due to global warming the time, when the navigation is possible, is increasing from year to year. Thereby NSR is now navigable during four months along all its length, and it is navigable for the whole year long in a part from Murmansk to Dudinka. According to this data we will assume in our case study that NSR is navigable for a whole year, due to the fact, that it is possible in the future and till the time, when such a permanent loop route will be organized. That will be assumed that a company has bought a number of DAS and uses them for trans-international transportation for the whole year.

The following questions should be answered during the case:

1. What is the optimal number of ships for permanent liner route between Rotterdam and Yokohama, when using the NSR?
2. Is it economically feasible to transfer containers through NSR?
3. What are the costs for transferring one TEU through the NSR?

For each route, the total one-way transit time is first calculated depending on distance, speed and waiting time. Based on this, the number of trips that ships can make per year is obtained, followed by annual revenue, overall cost and the annual profit.

The following assumptions also will be made:

1. The sailing distance between Rotterdam and Yokohama is 7100 nautical miles through NSR and 11400 nautical miles through Suez Canal.

2. According to NSR ice conditions, it will be assumed that 300 nautical miles will be covered with ice and the rest 6800 nautical miles are open water from July till December.

3. According to technical documentation (MS Norilskiy Nickel - Specialised Container/Cargo Vessel, 2010), the service speed of DAS is 15.5 knots, when ice-breaking speed is 3 knots. But here it will be assumed that the ship is able to keep service speed of 18 knots and ice-breaking speed of 5 knots, due to a technology development, which can happen till the implementation of the project. Also nowadays DAS is able to rush through the ice of 1.5 meters of thickness without assistance from other ice-breaking vessels. Here it is proposed that ships will be able to work without ice-breaker support at the whole length of the route.

4. Average service speed for vessels, navigating through Suez Canal is 18 knots.

5. Container capacity of DAS is 650 TEU.

6. According to market reports, the cost of building a double acting containership is approximately 60 million Euro.

5.2.1. Creating a schedule

First of all, it is needed to find out the number of ships, needed for creation of schedule for a loop transportation and estimation the schedule itself. This is just a model, but it was made to be as close to a schedule, which can be developed for such a line in real, as it is possible.

The fictional regular line starts from Rotterdam, then a ship visits Murmansk and then it follows to Yokohama through NSR. It is assumed that a ship is able to travel 18 knots in open water and 5 knots in ice fields, thus its average speed at the route from July to December will be approximately 14 knots. Total waiting and handling time, according to Liu and Kronbak (2009), will be 4 days. (Liu and Kronbak (2009) supposed such delay time for the Royal Route, but here it is supposed for NSR, because, if the route is used for such a regular transportation, there should not be such a lot of bureaucracy, that delays the departures nowadays). Thus a round trip through the route will need 50 days.

Port	Transit time
Eastbound	
Rotterdam	0
Murmansk	4
Yokohama	25
Westbound	
Yokohama	26
Murmansk	36
Rotterdam	50

Table 5.1: Round trip schedule

The ship will be able to make 365 / 50 = 7.3 round trips per year. To provide a weekly service, which will be beneficial for each port, 52 sailings will therefore be needed 52 / 7.3 = 7.1 or 8 ships on rotation.

The following schedule can be made:

Total distance for a loop	14200 nautical miles
Distance, travelled through ice fields	1400 nautical miles
Distance, travelled through open water	12800 nautical miles
Time of sailing through ice fields (5 knots)	11,7 days
Time of sailing through open water (18 knots)	29,6 days
Total sailing time	41,3 days
Total waiting time	8 days
Total loop time	49,3 days

From the calculations, mentioned above, it can be seen that mathematically 7.1 ships will be able to provide such a service with weekly departures, but that will not take into account risks of delays, due to weather conditions, vessel maintenance, troubles with handling or any other possible reasons. As practice shows, it is very difficult to avoid some small deviations from the schedule, which may finally cause clients' dissatisfaction and, as a consequence, financial loses. Due to this logic, the number of ships should be rounded into the larger side, and the operating company should have 8 ships, to be able to face the risks of delays. Now, when the optimal number of ships is determined, the operating costs for such a line should be calculated.

5.2.2. Calculating initial investment

At this step the TEU capacity of vessels will be discussed. At the case study a Specialized Container/Cargo Vessel MS Norilskiy Nickel will be taken as an example of DAS and like a basis or prototype of a vessel, used at the case. The capacity of modern double acting ships is not comparable to containerships, which travel through Suez Canal, and it estimated only 650 TEU. This capacity is chosen for particular economical study to get a result, which will be close to real situation as much as possible. The price of a vessel of such a class is 65-70 million USD. That is much higher, than a price for a usual ship of such capacity, but vessels of high ice class and equipped with patented ABB Azipod propulsion system cost approximately 30-40% more than usual container ships. For this study the price of 60 million is picked up, because there is a high probability, that the price for such a technology will be reduced till the time, when the project will be implemented.

Nowadays many banks, like Cre´dit Suisse Ship Finance, the German bank HSH Nordbank AG or the Norwegian DnB Nor Group, has loan programs, targeted for support companies, which buy ice-classed ships (Verny, Grigentin, 2009). Usually these banks can suggest loans, covering from 60% to 80% of the vessel price. Such loans should be returned before the 20^{th} anniversary of a ship. The loans are indexed to LIBOR (London Inter Bank Offered Rate), the latest average is approximately 0.3%. To this rate, an additional margin varying according to the shipping line's reputation has to be added.

Taking into account the 60 million USD price of the ship and supposing 70% debt, the annual payment comes to approximately 2.8 million USD. The annual payment is calculated using the formula of annuity, mentioned in chapter 3.8, and the LIBOR. As it was decided above, eight vessels are needed, so the total amount of investment will be calculated as follows:

$$60\ 000\ 000 * 8 = 480\ 000\ 000 \text{ USD}$$

The amount above is needed; if there is no debt and the company is able buy the ships right now.

$$480\ 000\ 000 * (1 - 0.7) = 144\ 000\ 000 \text{ USD}$$

144 000 000 USD - this is the amount of initial investment, when the company has to take a debt. As it was mentioned above, the annual payment for one ship will be approximately 2.8 million USD.

2 800 000 * 8 = 22 400 000 USD

22 400 000 USD is the total annual interest payment for eight vessels.

Further the calculation of operational costs, annual costs per ship and costs per one TEU are provided. The amount of the total investment and the alternative costs are not taken into account, because the costs are calculated for further comparison to the route through Suez Canal. Lui and Kronbak (2009) have the same amount of total investment, so the alternative costs are similar in both cases.

5.2.3. Calculating operational costs

Usually the containerships, which sail between East and West, are not completely loaded, while on a route. Due to statistics (Verny, Grigentin, 2009), approximate load of such ships, while sailing East is 80%, but it is near 100%, when sailing back to Europe, due to larger import from East. When sailing East, the rest of space will be filled with empty containers, returning back.

The fuel consumption and cost should be calculated next. While the ship navigates at sea IFO380 fuel (intermediate fuel oil) is used. The price for such fuel was 472 USD, according to the Rotterdam index value recorded on Bunker World in April 2010.

The vessel, equipped with Azipod propulsion system, consumes in average approximately 39 tons per day (Suojanen et al., 2006). As it was mentioned above, the vessel makes 7.3 round trips per year; each of them takes 50 days, which include 8 days of waiting time. It can be concluded, that the vessel will be sailing 7.3 * (50 – 8) ~ 306 days a year and consuming 11 957 tons of fuel per year. Taking into account the price of fuel, the total annual costs for fuel for one vessel will be 5 643 704 USD. That means 18 443 USD per sailing day per vessel or 15 462 USD per day if divided for the whole year.

The required crew is 25 people (MS Norilskiy Nickel - Specialised Container/Cargo Vessel, 2010). The monthly costs of such a crew can be estimated at 130 000 USD. This is the lowest reasonable level for the crew salary. Thus that appears that 130 000 * 12 = 1 560 000 USD per year is needed for one ship crew salary.

The Northern route will also require the installation of sophisticated navigation systems on board, for iceberg detection for example, as well as a high level of technical training for the officers (navigation in glacial waters). Seamen who have already worked in such extreme

conditions will be able to earn more, than while sailing at Royal Route, using their experience (Verny, Grigentin, 2009).

Insurance is also should be included into calculations, because it is a significant part of total costs. Marine Insurance covers the loss or damage of ships, cargo, terminals, and any transport or cargo by which property is transferred, acquired, or held between the points of origin and final destination. Marine insurance is divided into three main parts:

- Hull and machinery insurance. This type of insurance spreads for the hull of vessel, its engines, and any other machinery and devices, which stay on board permanently, but not for the cargo.
- Cargo insurance. It covers any losses occurred during the transportation and caused by damaging or losing the cargo.
- Marine liability. It includes insurance for liability or property damages to a third party, while engaged in marine related operations.

Hull and cargo insurance are handled by commercial insurers whereas liability insurance is provided for 90% of vessels by mutual companies known as P&I Clubs (Verny, Grigentin, 2009). These mutual companies will provide compensation of damage victims, thus they guarantee that the ship owner will not lose operating profit or get the vessel confiscated. Despite the global warming, the ice-fields and icebergs in Arctic are still providing threat and risk of damage for the ship owners, so due to the extreme navigation conditions on the NSR, insurers such as Axa Corporation would not provide cover to clients (Maersk, CMA-CGM, etc.) wishing to run a regular shipping service. At this case the average insurance cost is taken. The cargo insurance depends on the value of cargo and will not be taken into account. If needed, it can be added later for the particular cargo.

Unfortunately, we do not have possibility to estimate precisely the insurance premium, so it will be calculated in relevance to the numbers, mentioned by Verny and Grigentin (2009).

The costs of maintenance and lubricants are taken approximately, but the values are relevant to the numbers mentioned in similar studies.

	Costs per year, USD	Costs per loop, USD	Costs per day, USD	Costs per filled TEU Eastbound, USD	Costs per filled TEU Westbound, USD
Interest payment	2 800 000	383 562	7 671	369	295
Fuel oil	5 643 704	773 110	15 462	743	595
Crew	1 560 000	213 699	4 274	205	164
Maintenance	76 772	10 517	210	10	8
P&I insurance	141 273	19 353	387	19	15
H&M insurance	140 000	19 178	384	18	15
Lubricants	25187	3 450	69	3	3
Management, etc.	365000	50 000	1 000	48	38
Total	**10 752 147**	**1 472 868**	**29 457**	**1 416**	**1 133**

Table 5.2: Generalized list of costs for the NSR

The total costs per year appear to be 10.7 million USD for one vessel. The costs of transferring one TEU Eastbound are 1 416 USD, and 1 133 USD for opposite direction.

The amount for the first investment will be approximately 144 000 000 USD and annual interest payment for the creditor will appear 22 400 000 USD. The debt will be covered in 20 years.

5.3. Comparison to the Royal Route

The numbers that were calculated at this study differ from numbers, which the other researchers received during their work. This effect can be explained by the fact that the input data that was used at this case differs from the input data of other researchers. For example, the number of ships, needed for the regular line, is eight and that is more than the same measure at the Verny and Grigentin (2009) research. The difference in vessel types and their speeds, and the difference in the destination points is the reason for such a deviation in research results. But at this case study all the proportions were kept.

Trying to compare the results with the results of Lui and Kronbak (2009), it is needed to recalculate their data, using real fuel price and taking into account the difference in cargo capacity of the vessels. Lui and Kronbak (2009) took a 4300 TEU container ship with supposed 60% load and compared the feasibility of using such a ship during transportation through Suez Canal and NSR, varying the fuel oil price and ice condition at the NSR.

They found out that the fuel consumption will be 37 795 tons per ship per year and total costs amount 22 516 064 USD with the fuel oil price 350 USD per ton. It means that the total cost of fuel per year can be subtracted from total operating costs to receive the costs, which are not relative to fuel price. These costs include interest payment, operating costs, like manning, insurance, maintenance, administrative and other costs. Then the fuel costs, calculated with the new oil price (472 USD per ton), will be added to that amount. Later the costs per one TEU can be calculated by dividing that number to the quantity of trips per year and the amount of filled containers on board during one trip. The following table of data and results can be provided:

Total cost per year (fuel price is 350 USD/ton)	22516064	USD		
Fuel consumption per year	37 795	tons		
Total cost per year (fuel price is 472 USD/ton)	27914040	USD		
Trips per year supposed by Lui and Kronbak (2009)	11.05	trips		
Ship capacity	4300	TEU		
Ship load per trip	60	% or	2580	TEU
Costs per one TEU	979	USD		

Table 5.3: Costs calculation of transfer through Suez Canal for one filled TEU

The cost of transportation of one TEU through the Suez Canal appears to be approximately 979 USD.

5.4. Discussion

This case study shows the approximate assumptions, when the NSR will be interesting for transport companies and competitive with the Royal Route. The average cost for transportation of one TEU through the Royal Route appears to be 1 000 USD, when using 4 000 TEU vessel, but the time for such transportation is varying from 28 to 30 days (Verny, Grigentin, 2009), when there is a possibility to transfer the cargo through the NSR in 24 – 25 days. According to this case study, 133 USD per TEU of extra costs saves up to five days in transportation from East to West. That can be an advantage of the NSR, but there are few points, at which the accent should be made.

First of all, the circumstances and assumptions that were made at this case study are not real nowadays. The service speed of DAS nowadays is few knots lower, than mentioned above. The price for them is higher, and the navigation at the NSR is not possible without ice-breaker support during the whole year or at the full length of the route.

Secondly, the total TEU capacity of the line, described in the case study, is quite low, because of low capacity of DAS in comparison with container ships, which are navigating nowadays through the Suez Canal.

At third, the waiting time for the NSR is twice much than the waiting time at Suez Canal nowadays. The main reason is the weather conditions and huge amount of documents, needed to be collected for passage through Russian waters.

Thus there are several directions of improvements that can be made, except the weather and ice conditions that cannot be influenced by human beings. If the target of development of NSR is set, than the first goal will be to improve the ships, that will serve the route. If talking about Double Acting Ships or other ships, that do not need ice-breaking assistance, the ice-resistance, service speed and the speed at ice fields should be improved. Also it is needed to enlarge the capacity of such ships. That will allow reducing the costs per TEU, using economy of scale.

Thus the following conclusions can be made:

1. Eight double acting ships will be enough in nearest future for establishing permanent liner transportation with weekly departures.

2. The cost of transportation of one TEU through the NSR from East to West is 1 133 USD and 1416 USD, while transferring in opposite direction. The difference in costs can be explained by the distinctions in the volume of import between East and West. Thus the average cost of transportation from Rotterdam to Yokohama through the NSR is 1274 USD.

3. The use of NSR can be feasible, because the transfer costs at the NSR are 23% higher than the same costs at the Royal Route, but the use of NSR can help to save transfer time by approximately 22% (25 days at NSR versus 32 days at Royal Route).

4. If the technology develops, the technical characteristics of double acting container vessels will be improved: the capacity will be enlarged, the speed in open water and speed at the ice fields will be increased; all these improvements will help to make the East-West transportation through the NSR more attractive for transport companies by decreasing the costs of transportation per one TEU.

The results of the case study are collected in the generalized table below:

	Costs per ship per year at NSR, USD	**Costs per filled TEU Eastbound at NSR, USD**	**Costs per filled TEU Westbound at NSR, USD**	**Average costs per filled TEU at NSR, USD**	**Costs per ship per year at Suez Canal, USD**	**Average costs per filled TEU at Suez Canal, USD**
Interest payment	2 800 000	369	295	332	5 230 000	183
Fuel oil	5 643 704	743	595	669	17 839 240	626
Crew	1 560 000	205	164	184,5	900 000	32
Maintenance	76 772	10	8	9	432 000	15
Lubricants	25187	3	3	3		
P&I insurance	141 273	19	15	17	252 000	9
H&M insurance	140 000	18	15	16,5	252 000	9
Passage fee					2 648 800	93
Management, etc.	365000	48	38	43	360 000	13
Total	**10 752 147**	**1 416**	**1 133**	**1 275**	**27 914 040**	**979**

Table 5.4: Generalized table of costs for two routes (NSR and Royal Route)

5.5. Summary

In this chapter the interviews and collected secondary data were analyzed and discussed. The case study was conducted and let the authors to make the conclusions and answer for the research questions stated at the beginning of the study. Finally, the generalized table was made to combine the data of the case study in one.

6. Conclusions

This research was observing current condition of the Northern Sea Route and the possibility of transit container transportation by it. As the purpose of the study was not only descriptive, the research has the calculation of economic feasibility jointly with the empirical data.

The study included the following targets:

- a theoretical study based on literature about freight transport, container shipping, transportation demand and its elasticity, ports and terminals;
- the empirical study of the NSR development condition and the normative and legal documents, regulating the passage through the NSR;
- highlighting concrete problems and obstacles, which may be faced by shipping companies, while navigating through the NSR;
- calculation of possible economic feasibility of using the NSR for international container shipping pari passu with the Route through the Suez Canal and defining the strategy of the NSR development, which can allow that in nearest future.

The empirical part is wide and includes various data about the Northern Sea Route, including the history of its development, current state of NSR ports, legal framework development, and description of main interested parties of the NSR development.

The idea of NSR usage has 150 years history, but through the history the Route was firstly the unstable national transportation line, but not the popular international trade route. This fact influenced the development of the infrastructure of the Route and the Rules of navigation. Russian socio-economic crisis of 1990 hit the development of the NSR and paused it for approximately ten years. Nowadays many international and Russian parties are interested in further development of the NSR, but the question of economical feasibility of the Route usage still stays open.

The information, gathered from literature and publications during the empirical part of the research, is confirmed in the interviews with the leading experts from the companies and organizations, interested in the NSR development.

The analysis of the collected data shows that today's conditions of the NSR, its infrastructure and legal framework are not totally appropriate for transit international container shipping. There the following key issues, noticed from analysis of the empirical framework:

1. Extreme weather conditions; ice-fields, which slows the speed of navigation; short navigational season.
2. The lack of ice-class vessels and ice-breakers for providing the guiding of container vessels.
3. The high price of the vessels.
4. Very complicated bureaucratic process of receiving the permission for passage through the NSR.
5. Difficulties with getting insurance, due to high risks of damaging ship and cargo; the high insurance premium, if the insurance is granted.
6. The Guidelines for navigation are not perfect and centralized, that may cause the safety level reduction.

These are main directions of further possible improvements in the NSR activity. As the case study had shown, even small improvements in these areas can afford the NSR to be economically feasible in comparison to the Royal Route. The cost of transportation of one TEU can be proportionally higher to the decrease in transportation time.

There are many parties, interested in further successful development of the NSR as a trade route. They include Russian Government, Norwegian Barents Secretariat, Russian and foreign shipping companies and Noncommercial Partnership of the Coordination of Northern Sea Route Usages, which represents the interest of such organizations as United Industrial Corporation, Ltd., ITNAARI, LUKOIL-Kaliningradmorneft, Arctic Shipping Company, Arctic Trade and Transport Company, Gazflot, Far Eastern Shipping Company, Lenmorniiproekt, Kurchatov Institute, and up to 300 others.

The work at improvement of the NSR quality continues – the reconstruction of some NSR ports is provided, the work at the Guidelines for safe navigation continues being developed by the IMO. But still the IMO Guidelines for navigation in ice-waters is not obligatory; it can not provide the needed level of safety, because everyone can decide by themselves if they wish to follow these Guidelines or not. It is clear that such a regulation should be more centralized and the base document should be released. Senior researcher at Det Norske Veritas and adventurer Knut Espen Solberg, who has extensive first hand and theoretical experience about sailing in

high latitudes, during the interview made an accent that there are many different risks, while sailing through the NSR, but there is no strict regulations, covering the procedure of measuring and avoiding these risks.

There are various risks, connected to the navigation in Arctic. They are risks of damaging cargo, risk of being out of schedule, "*risk of ice accumulation on the vessel, getting stuck in the ice, hitting the ground at the coast of Russia, because there is a shallow area, but the risks are not much higher in comparison to usual navigation, while the consequences can be much bigger, and that influence overall risk picture*", as Mr. Solberg said. Some procedure of reduction of these risks is mentioned in the IMO Guidelines, but nowadays these Guidelines are not ratified by all countries.

It can be concluded that the use of NSR for international container shipping is not a question of technology, but it is a question of price and legislation. The global warming and reduction of the ice in Arctic can help to reduce the costs for ice-breaking guidance and modern technology may allow reducing operating costs and transportation time. If the appropriate and transparent legal framework is developed in the nearest future and there is a possibility to reduce the transportation costs to the level, mentioned in this research, than the Northern Sea Route will be feasible for container shipping and can become a competitor or a supplement to the route through Suez Canal.

6.1. Future Research Purposes

Current study is devoted to the research of the possibility of the NSR wide-opening for the international transit container shipping and the problems, which prevent that. But the international route is a good subject for the numerous possible studies from different sides.

During the research study it was collected a lot of empirical data which can be used for the future researches. Due to the limitation of time and possibilities, the authors were not able to collect the opinions of all the stakeholders.

Despite of this research theme, the NSR gets the prevalent attention from oil, gas and other mineral resources transporters. The increasing interest to the development of the route is mainly caused by the development of offshore deposits in the Arctic waters.

The current research uncovered the difficult bureaucratic apparat, total decentralization of government bodies operations and absence of proper guideline for the shippers. This is the problem which blocks the usage of the NSR by non-Russian transporters.

According to this, it is possible to make the assumptions about future studies. The authors believe that it is relevant to emphasize on design of the proper legal acts and guidelines for passing the NSR, measure of its significance and influence of the demand for the route.

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8. Appendixes

8.1. Appendix 1

Interview Guide 1. The preliminary set of questions for the respondent of Barents Ramboll:

1. Recently, mass media starts to report about overcapacity of Suez and Panama Canals, the main trading arteries. How do you think if this is a true?
2. Can the development of Northern Sea Route (NSR) become a worthy alternative to Suez Canal?
3. Despite of distance reduction advantage (for example, the distance traversed by vessels from the port of Murmansk to the port of Yokohama (Japan) through NSR is only 5770 nautical miles, through Suez Canal - 12,840 nautical miles), NSR has important disadvantage: its seasonality. Ice doesn't allow to provide the whole-year navigation. How do you believe, can it be fixed by the modern technological achievement (for example, using of icebreakers) and will it be profitable for clients of NSR?
4. In your opinion, will the broadening of Suez Canal affect the development of NSR?
5. Now, main users of NSR are Russian companies, such as Gazprom, Norilsk Nickel, Lukoil. In 2009, the German company Beluga Group sent two of their ships through NSR. How do you propose, which companies will be highly interested in development of NSR?
6. How do you think, can spreading of piracy in southern trading routes become one of the prevalent criteria in decision acceptance of shipping route?
7. It is assumed that NSR will mainly serve for oil transportation, in your opinion, does NSR have a possibility to attract non-resourced clients?
8. How do you think, is Russian Federation ready for executing of the international trading route? If not, what should be done for this?

8.2. Appendix 2

Interview Guide 2. The preliminary set of questions for the respondent of Beluga Shipping:

1. Could you please describe the risks, that Beluga group was faced while organizing the passage through the NSR?
2. Service of which insurance company did you use?
3. How did you manage to reduce the following risks:
    - risk of damaging cargo?
    - risk of being out of schedule?
4. If it is not a confidential data, what was the insurance premium?
5. How long did it take to make all the required documents for passing NSR?
6. Does such bureaucracy cost a lot?
7. Could you, please, name the documents and permissions that you have finally collected to get an approval from the Russian side?
8. How can you comment the condition of Russian northern ports? Are they ready for regular transit through NSR? What should be done first of all?

8.3. Appendix 3

Interview Guide 3. The preliminary set of questions for the respondent of DNV:

1. What risks will be faced while navigating the Northern Sea Route (NSR)?
2. What is the best way to estimate these risks?
3. Could you suggest the ways of minimizing such risks? (Risks of damaging the cargo, risks of delays) What piece of advice would you give to a company, which decided to send their ships through NSR?
4. What shipping companies or ship owners does DNV cooperate now with?
5. In your opinion, should or can NSR be used for transit international container shipment?
6. Can the Double acting container ships be used for such transportation? Will that be safe?
7. The companies, that will send ships to NSR usually have to pay high insurance, but are there any ways to reduce the fee?
8. What are the limits for greenhouse gas emissions for the High North?

8.4. Appendix 4

Interview Guide 4. The preliminary set of questions for the respondents of Ocean Futures:

1. What can be the consequences of wrong and careless nature management at the High North?
2. What are the limits for greenhouse gas emissions for the High North?
3. Can the more intensive navigation at the High North influence badly the ecological situation and probably cause an ecological disaster?
4. From an environmental point of view, Arctic shipping poses a threat to the regions unique ecosystems. Can this threat be effectively mitigated through careful planning and effective regulation in areas of high risk? How?
5. Are there any special requirements that the ship should meet before it will be allowed to work at High North?
6. What do you think about Double Acting Ships? Are they appropriate for the use at the High North?
7. What are the main advantages of new series of circumpolar maps that are being developed by Ocean Futures in comparison to existing ones?
8. How the production of circumpolar maps can help in development of NSR?
9. Ocean Futures has been prosecuting the project Shipping in Arctic Waters on the base of gathered data by INSROP project since January,2009. How many changes have been already revealed in development of NSR as the shipping route since the last project ?
10. What parties are participating at this part of the project?
11. What sea routes are also analyzed during the project?
12. What are the preliminary results of the project?
13. Is it planned to finish the project this year, or it will be prolonged and further developed?
14. How do you think, is Russian Federation ready for executing of the international trading route? If not, what should be done for this?
15. Now, main users of NSR are Russian companies, such as Gazprom, Norilsk Nickel, Lukoil. In 2009, the German company Beluga Group sent two of their ships through NSR. How do you propose, which companies will be highly interested in development of NSR?

16. It is assumed that NSR will mainly serve for oil transportation; in your opinion, does NSR have a possibility to attract non-resourced clients?

8.5. Appendix 5.

Map of depths along NSR.

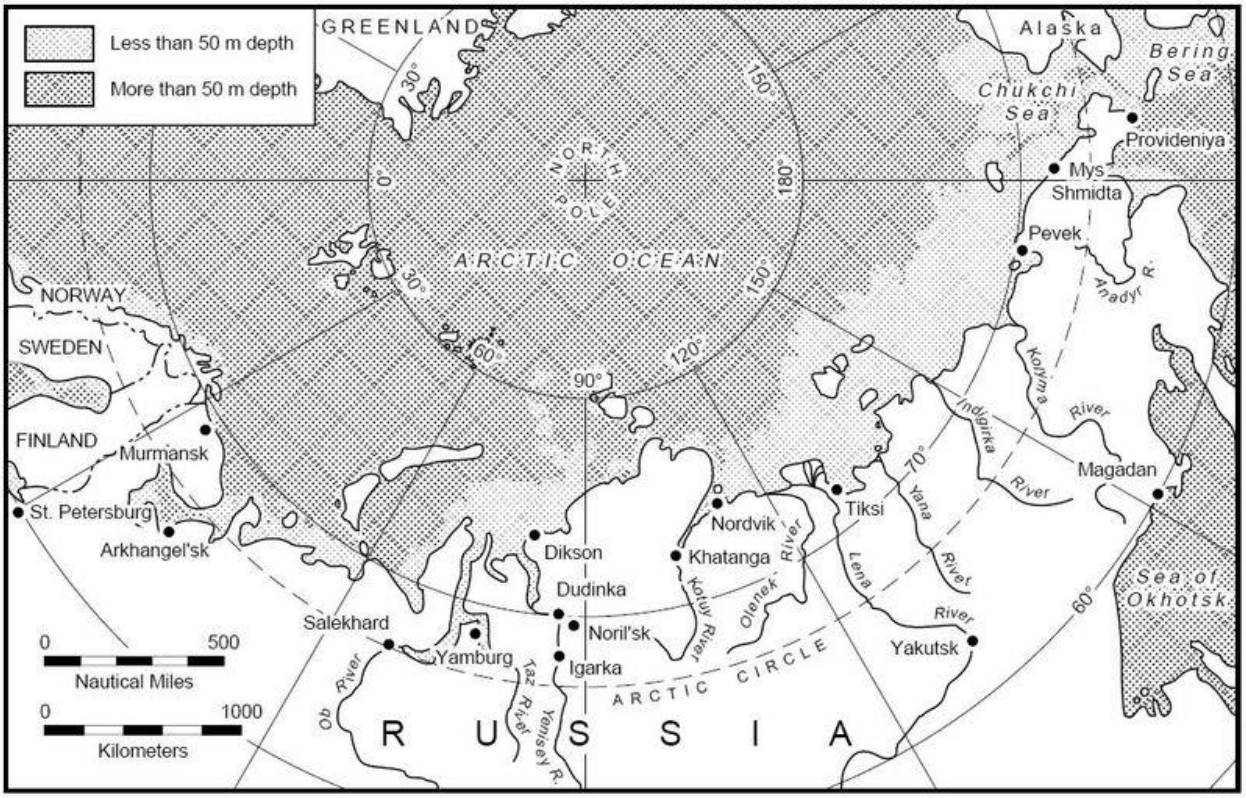

Figure 13. The bathymetry of the Russian Arctic.

Source: http://benmuse.typepad.com/.a/6a00d8341d9cb353ef010535b9c90a970c-800wi